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The Impact of Liberalizing Barriers to Foreign Direct Investment in Services: The Case of Russian Accession to the World Trade Organization

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Abstract: In this paper we employ a computable general equilibrium model of the Russian economy to assess the impact of accession to the World Trade Organization (WTO), which encompasses improved market access, tariff reduction and reduction of barriers against multinational service providers. We assume that foreign direct investment in business services is necessary for multinationals to compete well with Russian business service providers, but cross-border service provision is also present. The model incorporates productivity effects in both goods and services markets endogenously, through a Dixit-Stiglitz framework. The ad valorem equivalent of barriers to foreign direct investment have been estimated based on detailed questionnaires completed by specialized research institutes in Russia. We estimate that Russia will gain about 7.2 percent of the value of Russian consumption in the medium run from WTO accession and up to 24 percent in the long run. We estimate that the largest gains to Russia will derive from liberalization of barriers against multinational service providers. Piecemeal and systematic sensitivity analysis shows that our results are robust.

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I. Introduction

Russia applied for membership in the General Agreement on Tariffs and Trade (GATT) in June 1993 and the GATT Working Party was transformed into the World Trade Organization (WTO) Working Party in 1995. After years of negotiations, momentum for accession built when President Vladimir Putin made accession a priority of his administration.

In Russia, numerous industrialists, policy analysts and even the former Prime Minister have called for an assessment of the gains and losses from WTO accession and for an assessment of the impact on different sectors of the economy. Russian goods providers are concerned that a fall in tariffs will imply increased competition from foreign goods providers and a decline in their market share. Russian service providers are concerned that liberalized rules on new foreign direct investment (FDI) will lead to increased competition from multinational service providers in Russia. The government has appropriately replied that when the economy as a whole is considered, the reduction in the tariff in any one sector does not mean that sector will decline, i.e., in general equilibrium the effects may be favorable for many sectors whose protection is cut. Moreover, the government argues that Russian exporters will obtain improved access to the markets of WTO member countries. But some commentators remain skeptical, in part because there is a lack of quantitative estimates of the impacts, and in part because the sources of the gains have not been well articulated.

In this paper we develop a 35-sector, small open economy, comparative static computable general equilibrium model of Russia that we believe is appropriate to evaluate the impact of Russian accession to the WTO. We document that although the Russian tariff structure has some problem areas and can be liberalized, it is not a highly distorted tariff structure. On the other hand, barriers to foreign direct investors in several key business service sectors are quite substantial and are the focus of intense negotiations between Russia and the WTO Working Party. Consequently, a serious evaluation of Russian WTO accession requires developing a model that is capable of assessing the impact of liberalization of barriers on FDI in the service sector.

Our key modeling assumptions are that: a substantial portion of business services require a domestic presence; multinational service providers import some specialized capital or labor as part of their decision to establish a domestic presence; and business services supplied with a domestic presence are supplied by imperfectly competitive firms that produce a unique variety of the service. We adopt the Dixit-Stiglitz-Ethier structure for business services (and for goods with increasing returns to scale) that implies endogenous productivity gains from the net introduction of new varieties.[1]

We argue that the gains to Russia from WTO accession derive from four principal effects. First, there will be improved access to the markets of non-CIS countries in selected products. Russia has already negotiated most-favored nation (MFN) status on a bilateral basis with most of its important trading partners, so Russia's exporters will not see an immediate reduction in the tariffs they face and this effect may not be expected to be large. But Russia will have improved rights under anti-dumping and countervailing duty investigations in its export markets, which is the source of the improved access we model.[2] Second, tariff reduction on goods will induce improved domestic resource allocation and increase the number of varieties of imports in imperfectly competitive sectors. The latter will increase total factor productivity in downstream sectors due to a Dixit-Stiglitz-Ethier externality. Third, reduction in barriers against multinational service providers will increase the number of service varieties available in Russia. The increase in variety will increase total factor productivity (or lower the quality-adjusted costs) in sectors that use business services. Fourth, there will be positive effects on the investment climate from increases in the rate of return to capital. We model this impact in a comparative steady-state model, which produces an upper bound estimate of the gains from an increase in capital stock due to trade liberalization.

This paper is innovative because it is the first paper to numerically assess liberalization of barriers against foreign direct investors in business services in a multi-sector applied general equilibrium model

[1] Elasticities of substitution for product categories in the Dixit-Stiglitz framework have been estimated by Broda and Weinstein (2004). They estimate that, although there are variances within the groups, for agriculture, services and goods the Dixit-Stiglitz elasticitiy of substitution is close to three. We choose three as our central Dixit-Stiglitz elasticity of substitution.

[2] WTO accession will grant an "injury determination" to Russia in antidumping cases in WTO members countries. Combined with the decision by the US to treat Russia as a market economy will imply Russian exporters may have considerably improved rights in these cases in the US. But market economy status may be denied in particular cases, so it will be necessary to see how this is implemented in practice.

where the Dixit-Stiglitz variety-productivity effects are important to the results. There have been a number of theoretical papers modeling foreign direct investment liberalization in services (Markusen (1989; 1990) and Markusen and Venables (1998; 2000)). Regarding numerical efforts, Markusen, Rutherford and Tarr (2000) develop a stylized model where foreign direct investment is required for entry of new multinational competitors in services, but they do not apply this model to the data of an actual economy. Brown and Stern (2001) and Dee et al. (2003) employ multi-country numerical models with many of the same features of Markusen, Rutherford and Tarr. Their models contain three sectors — agriculture, manufacturing and services — and are thus also rather stylized. Results in the Brown and Stern paper depend crucially on capital flows between nations. For example, they estimate that Japan will lose from multilateral liberalization of barriers to FDI service providers because Japan is a capital exporting nation. In Dee et al. (2003), multinationals are assumed to capture the quota rents initially. So results of liberalization depend crucially on the fact that liberalization transfers rents to capital-importing countries. The Dixit-Stiglitz endogenous productivity effect from the impact of service sector liberalization on product variety is not mentioned in the results of Brown and Stern, and is interpreted as of little relevance in Dee et al. [3]

We estimate that the gains to Russia (measured as Hicksian equivalent variation) from WTO accession are 7.2 percent of Russian consumption (or 3.3 percent of GDP) in the medium run, and could be as high as 23.6 percent of Russian consumption (11.0 percent of GDP) in the long run (using our comparative steady-state model). To understand the sources of these gains, we execute several scenarios that allow us to decompose the impacts. Tariff reform only is responsible for 1.3 percentage points of the gain in consumption. Improved market access accounts for 0.6 percentage points of the welfare gain. We estimate that the gains from FDI liberalization in services are 5.2 percent of the value of Russian consumption, which amounts to over 70 percent of the total gains from Russian WTO accession. Thus, while improving its offer to foreign service providers within the context of the GATS has been one the most difficult aspects of Russia's negotiation for WTO accession, our estimates suggest that the most

[3] There have also been numerical estimates of the benefits of services liberalization where services trade is treated analogously to goods trade, i.e. trade in services is assumed to be entirely cross-border and subject to tariffs. For example, see Brown, Deardorff, Fox and Stern (1996).

important component of WTO accession for Russia in terms of the welfare gains is liberalization of its barriers against FDI in service sectors.

The crucial importance in the Russian context of liberalization of barriers to FDI reflects the starting point of the analysis; that is, we assess that Russia has done more to lower it tariffs on goods than it has to liberalize its barriers to FDI in service sectors. The ad valorem equivalence of the barriers to foreign direct investors in business services has been estimated specifically for this study, as explained below. These estimates were based on surveys we commissioned of specialized service sector institutes in Russia to obtain data on the regulatory environment in the key business service sectors.

We examine the robustness of the results through extensive sensitivity analysis both with respect to modeling assumptions and with respect to parameter choice. This includes systematic sensitivity analysis in which we execute the model 30,000 times with random selection of parameter values within their specified probability distributions. We produce sample distributions and 50 and 95 percent confidence intervals of all key variables.

The paper is organized as follows. In section II we describe the model and the most important data. In section III we describe and interpret the central policy scenarios. In section IV we examine the impact of different modeling assumptions (or model closures) on the results and present the results of our piecemeal and systematic sensitivity analysis.

II. Overview of the Model and Key Data

Overview of the Model Formulation

An algebraic formulation of the model is available in Jensen, Rutherford and Tarr (2004). Here we provide a general description. Primary factors include skilled and unskilled labor; mobile capital; sector-specific capital in the energy sector reflecting the exhaustible resource; sector-specific capital in imperfectly competitive sectors; and primary inputs imported by multinational service providers, reflecting specialized management expertise or technology of the firm. The existence of sector-specific capital in

several sectors implies that there are decreasing returns to scale in the use of the mobile factors, and the supply curves in these sectors slope up.

There are 35 sectors shown in table 1. Regardless of sector, all firms minimize the cost of production. One category of sectors is *competitive goods and services sectors* produced under constant returns to scale and where price equals marginal costs with zero profits. This includes agriculture, forestry and construction. It also includes certain public services, like education and post office facilities, and key mineral industries.[4] In these sectors, products are differentiated by country of origin, i.e., we employ the Armington assumption. All Russian goods-producing firms (including imperfectly competitive firms) can sell on the domestic market or export. Russian firms optimize their output decision between exports and domestic sales based on relative prices and their constant elasticity of transformation production function.

Goods produced subject to increasing returns to scale are differentiated at the firm level. We assume that manufactured goods may be produced domestically or imported. Firms in these industries set prices such that marginal cost (which is constant) equals marginal revenue; and there is free entry, which drives profits to zero. For domestic firms, costs are defined by observed primary factor and intermediate inputs to that sector in the base year data. Foreigners produce the goods abroad at constant marginal cost but incur a fixed cost of operating in Russia. The cif import price of foreign goods is simply defined by the import price, and, by the zero profits assumption, in equilibrium the import price must cover fixed and marginal costs of foreign firms. We employ the standard Chamberlinian large-group monopolistic competition assumption within a Dixit-Stiglitz framework, which results in constant markups over marginal cost.

For simplicity we assume that the composition of fixed and marginal cost is identical in all firms producing under increasing returns to scale (in both goods and services). This assumption in our Dixit-

[4] Although electricity and gas are monopolistically controlled, prices are controlled by the government. Thus, market determined pricing to exploit market power is excluded by the government, and we maintain the assumption of price equal to marginal costs.

Stiglitz based Chamberlinian large-group model assures that output per firm for all firm types remains constant, i.e., the model does not produce rationalization gains or losses.

The number of varieties affects the productivity of the use of imperfectly competitive goods based on the standard Dixit-Stiglitz formulation. The effective cost function for users of goods produced subject to increasing returns to scale declines in the total number of firms in the industry.

The third category of sectors is *service sectors that produce in Russia under increasing returns to scale and imperfect competition,* such as telecommunications, financial services, most business services and transportation services. In service sectors, we observe that some services are provided by foreign service providers on a cross-border basis analogous to goods providers from abroad. But a large share of business services are provided by service providers with a domestic presence, both multinational and Russian.[5] Our model allows for both types of foreign service provision in these sectors. There are cross-border services allowed in this sector and they are provided from abroad at constant costs—this is analogous to competitive provision of goods from abroad. Cross-border services, however, are not good substitutes for service providers who have a presence in Russia.[6]

There are also multinational service providers that choose to establish a presence in Russia in order to compete with Russian firms directly in the Russian market. When multinational service providers decide to establish a domestic presence in Russia, they will import some of their technology or management expertise. That is, foreign direct investment generally entails importing specialized foreign inputs. Thus, the cost structure of multinationals differs from Russian service providers. Multinationals incur costs related to both imported primary inputs and Russian primary factors, in addition to intermediate factor inputs. Foreign provision of services differs from foreign provision of goods, since the service providers use Russian primary inputs. Domestic service providers do not import the specialized primary factors

[5] One estimate puts the world-wide cross-border share of trade in services at 41 percent and the share of trade in services provided by multinational affiliates at 38 percent. Travel expenditures 20 percent and compensation to employees working abroad 1 percent make up the difference. See Brown and Stern (2001, table 1).
[6] Daniels (1985) found that service providers charge higher prices when the service is provided at a distance.

available to the multinationals. Hence, domestic service firms incur primary factor costs related to Russian labor and capital only. These services are characterized by firm-level product differentiation. For multinational firms, the barriers to foreign direct investment affect their profitability and entry. Reduction in the constraints on foreign direct investment will induce foreign entry that will typically lead to productivity gains because when more varieties of service providers are available, buyers can obtain varieties that more closely fit their demands and needs (the Dixit-Stiglitz variety effect).

Comparative Steady-State Formulation. In this version of our model, we allow the capital stock to adjust to its steady-state equilibrium along with all of the model features we employ in our WTO reference case, i.e., we allow for tariff and FDI liberalization with endogenous productivity effects as above. We call this our comparative steady-state model. In the comparative static model, we assume that the capital stock is fixed and the rental rate on capital is endogenously determined. In the comparative steady-state model, the logic is reversed. We assume that the capital stock is in its initial steady-state equilibrium in the benchmark dataset, but that the capital stock will adjust to a new steady-state equilibrium based on a fixed rate of return demanded by investors. That is, if the trade policy shock happens to induce and increase in the rate of return on capital so that it exceeds the initial rate of return, investors will invest and expand the capital stock. Expansion of the capital stock drives down the marginal product of capital, i.e., it drives down the rental rate on capital, until the rate of return on capital falls back to the initial level.[7] To analyze trade policy, this comparative steady-state approach has been employed by many authors, including Harrison, Rutherford and Tarr (1996, 1997), Baldwin et al. (1999) and Francois et al. (1996). The approach, however, dates back to the 1970s, when Hansen and Koopmans (1972) and Dantzig and Manne (1974) used it. The approach ignores the foregone consumption necessary to achieve the higher level of investment and thus is an upper bound estimate of the long-run gains in the framework of the model assumptions.

[7] The rate of return on investment in our model is the rental rate on capital divided by the cost of a unit of the capital good.

Key Data

Ad Valorem Equivalence of Barriers to Foreign Direct Investment in Service Sectors.

Among the key restrictions against multinational service providers in Russia are: Rostelecom maintains a monopoly on long-distance fixed-line telephone services, affiliate branches of foreign banks are prohibited, and there is a quota on the multinational share of the insurance market.[8] Estimates of the ad valorem equivalence of these and other barriers to FDI in services are key to the results. Consequently, we commissioned 20-page surveys from Russian research institutes that specialize in these sectors and econometric estimates of these barriers based on the surveys.

The questionnaires provided us with data and descriptions and assessments of the regulatory environment in these sectors.[9] Using this information and interviews with specialist staff in Russia, as well as supplementary information, Kimura, Ando and Fujii (2004a, 2004b, 2004c) then estimate the ad valorem equivalence of barriers to foreign direct investment in several Russian sectors, namely in telecommunications; banking, insurance and securities; and maritime and air transportation services. The process involved converting the answers and data of the questionnaires into an index of restrictiveness in each industry. Kimura et al. then applied methodology explained in the volume by C. Findlay and T. Warren (2000), notably papers by Warren (2000), McGuire and Schulele (2000) and Kang (2000). For each of these service sectors, authors in the Findlay and Warren volume evaluated the regulatory environment across many countries. The price of services is then regressed against the regulatory barriers to determine the impact of any of the regulatory barriers on the price of services. Kimura et al. then assume that the international regression applies to Russia. Applying that regression and their assessments of the

[8] The protocol on Russian accession signed between the European Union and Russia on May 21, 2004 calls for the termination of the Rostelekom monopoly by 2007 and allows for an increase in the upper limit on the multinational share of the Russian insurance market. See UNCTAD (1996) or Brown and Stern (2001, table 2) for a complete list of barriers to FDI worldwide.

[9] This information was provided by the following Russian companies or research institutes: ZNIIS in the case of telecommunications, Expert RA for banking, insurance and securities; Central Marine Research and Design Institute (CNIIMF) for maritime transportation services and Infomost for air transportation services. We thank Vladimir Klimushin of ZNIIS; Dmitri Grishankov and Irina Shuvalova of ExpertRA; Boris Rybak and Dmitry Manakov of InfoMost; and Tamara Novikova, Juri Ivanov and Vladimir Vasiliev of CNIIMF. The questionnaires are available at

regulatory environment in Russia from the questionnaires and other information sources, they estimate the ad valorem impact of a reduction in barriers to foreign direct investment in these service sectors.[10] The results of the estimates are listed in table 2.[11] In the case of maritime and air transportation services, we assume that the barrier will only be cut by 15 percentage points, since pressure from the Working Party in these sectors is not strong.

Share of Expatriate Labor Employed by Multinational Service providers. The impact of liberalization of barriers to foreign direct investment in business service sectors on the demand for labor in these sectors will depend importantly on the share of expatriate labor used by multinational firms. We explain in the results section that despite the fact that multinationals use Russian labor less intensively than their Russian competitors, if multinationals use mostly Russian labor, their expansion is likely to increase the demand for Russian labor in these sectors.[12] We obtained estimates of the share of expatriate labor or

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www.worldbank.org/trade/russia-wto. The same sources provided the data on share of expatriate labor discussed below.

[10] Warren estimated quantity impacts and then using elasticity estimates was able to obtain price impacts. The estimates by Kimura et al. that we employ are for "discriminatory" barriers against foreign direct investment. Kimura et al. also estimate the impact of barriers on investment in services that are the sum of discriminatory and non-discriminatory barriers.

[11] Kimura et al. estimated that the price of telecommunications services in Russia are elevated by 10 percent due to barriers to multinational service providers. We believe that in telecommunications it is crucial to employ a differentiated product model to characterize competition between multinational and Russian telecommunications providers. This means that we interpret the estimates of Kimura et al. to indicate that the discriminatory tax on multinational service providers results in a 10 percent increase in the **composite price** of domestic and multinational service provision. Then the ad valorem tax on multinationals, say at rate x, must be above 10 percent since there is no discriminatory tax on domestic service providers and the composite price is a weighted average of domestic prices (which are untaxed) and multinational prices which are taxed at a rate x. More precisely, if x is the ad valorem equivalent of the barriers to multinational investment in telecommunications in Russia, s is the share of the market in Russia of multinationals, 10 percent is the amount by which telecommunications prices are elevated due to the barriers and if we assume Russian domestic service providers prices are unaffected, then we may solve for x from: $sx + (1-s)*0 = .10$. That is, $x= .10/s$ Our data indicate that $s = .15$, then $x = .67$ or 67 percent.

Barriers to foreign direct investment, however, have an indirect effect on the price of Russian telecommunications services. Consequently, $sx + (1-s)*y = .10$ may be more appropriate, where y is the amount by which the price of Russian telecommunication services are increased in the benchmark as a result of barriers on multinational telecommunications service providers. The value of y would have to be less than the value of the increase in composite services (0.1). It is likely that the indirect effect of barriers to foreign direct investment on the price of domestic Russian telecommunications services is less than 0.05, since the composite price increased by only 0.1 and lower values of y yield higher estimates of x. But if we take $y=.05$, then x equals 0.38, which is approximately the value estimated for financial services, of 0.33. We take a conservative estimate here of 0.33 for telecommunications.

[12] See Markusen, Rutherford and Tarr (2000) for a detailed explanation on why FDI may be a partial equilibrium substitute for domestic labor but a general equilibrium complement.

specialized technology not available to Russian firms that is used by multinational service providers in Russia from Russian research institutes that specialize in these sectors. In general, we found that multinational service providers use mostly Russian primary factor inputs and only small amounts of expatriate labor or specialized technology. In particular, the estimated share of foreign inputs used by multinationals in Russia is: telecommunications, 10 percent plus or minus 2 percent; financial services, 3 percent, plus or minus 2 percent; maritime transportation, 3 percent, plus or minus 2 percent; and air transportation, 12.5 percent, plus or minus 2.5 percent.

Tariff and Export Tax data. We estimate the tariff and export tax rates by sector in our model based on the following data and methodology. For the purpose of calculating the tariff and export tax rates, we obtained data on the trade flows from the 2001 Customs Statistics on the External Trade of the Russian Federation («Таможенная Статистика Внешней Торговли Российской Федераций»), a yearly publication from the Russian Customs Committee.[13] Import tariff rates and export taxes at the tariff line level were obtained from official government decrees available online; the data are current as of August 2002.[14]

Based on a Goskomstat a mapping from the tariff line data of the Customs Committee to the sectors in our input-output table, we calculated a weighted average tariff rate for the sectors of our model. We calculated these rates two ways: based on all imports (where the collected tariff rate as a percentage of all imports is 8.1 percent) and on non-CIS imports (where the collected tariffs as a percentage of non-CIS imports is 11.1 percent). The rates we employ in the model are the rates based on all imports. The rates based on all imports are lower because the base in the calculation includes CIS imports on which no tariffs are imposed. We believe collected tariff rates more closely approximate the protection a sector receives and the incentives it faces. Similar procedures are applied for export taxes. The results at the sector level are in table 2.

[13] The data in this paper, which were entered manually, are based on a level of aggregation reported by the Customs Committee that yields about 2000 tariff lines. We thank Ekaterina Krivonos and Eshref Trushin for their work on these data.

[14] The regulations can be found on the web page of the Customs Computer Service: www.tks.ru in the document database (Базы данных → Документы).

Applying these tariff rates across all sectors implies that tariff revenue in our model is about 1.6 percent of GDP in the initial equilibrium. Collected tariffs in Russia are closer to 1.1 percent of GDP.[15] There are several reasons why the collected tariffs in Russia are less than the legal rates on most favored nation (MFN) imports. Most notably, exemptions to the Russian tariff are available for regional agreements (most notably the CIS), personal imports and shuttle trade. Since we have data for CIS trade, we adjust for it by applying the MFN rates on all imports from the non-CIS. This slightly but not significantly biases upward the rates we employ relative to collected rates.

Export Tax Data. Analogous to the import trade data, the Russian State Customs Committee publishes data on export volumes and values. These data were also entered manually at the tariff line level. Unlike the tariff data that are listed by the Customs Committee, it was necessary to consult numerous regulations of the government of Russia to obtain the export taxes. Similar to the tariff data, the export taxes are sometimes ad valorem or sometimes the maximum of the ad valorem or specific tax rate. The results are reported in table 2.[16]

Input-output table. The core input-output model is the 1995 table produced by Goskomstat. The official table contained only 22 sectors, and importantly has little service sector disaggregation. Consequently, Russian input-output expert S. P. Baranov disaggregated this table into a 35 sector input output table. Baranov used unpublished data available to Goskomstat based on the surveys that were used to construct the 1995 table. The principal elements of this disaggregation were: a split of the oil and gas sector into oil, gas and oil processing; a split of the transport sector into railroad, maritime, air, pipeline, truck and other transportation services; the breakup of communication into post services and telecommunications; and disaggregation of the data in several business service sectors regarding market and non-market activities. The documentation by Baranov is available on the website listed above.

[15] International Monetary Fund, "Russian Federation: Selected Issues and Statistical Appendix," 2002.
[16] We thank Jan Strelka for painstaking work on the export data, which he compiled into a spreadsheet. He has also documented this work, including his sources for the export tax data.

III. Results

In our general WTO scenario, we assume that barriers against foreign direct investment are reduced as indicated in table 2; seven sectors subject to antidumping actions in export markets receive slightly improved market access. This is implemented as an exogenous increase in their export price as shown in table 2; and the tariff rates of all sectors are reduced by 50 percent.[17] We first discuss (and present in table 3) our estimates of the impact of Russian WTO accession on aggregate variables such as welfare and the real exchange rate, aggregate exports, the return to capital, skilled labor and unskilled labor, and the percentage change in tariff revenue. In order to obtain an assessment of the adjustment costs, we estimate the percentage of labor and mobile capital that must change industries. The gains come from a combination of effects, so we also estimate the comparative static impacts of the various components of WTO accession in order to assess their relative importance.

First we discuss the comparative static results. We shall also consider the results of assuming the time frame is long enough for capital to adjust to its new long-run, steady-state equilibrium in a scenario we call comparative steady-state. In addition, we evaluate a "short-run" scenario, in which all labor is "sector-specific".

Aggregate Welfare Effects of WTO Accession

We estimate that the welfare gains to Russia are equal to 7.2 percent of Russian consumption (or 3.3 percent of GDP) in the medium term. These gains derive from three key effects: (1) improved access to the markets of non-CIS countries in selected products; (2) Russian tariff reduction; and (3) liberalization of barriers to foreign direct investment in services sectors. We execute three scenarios that allow us to understand the relative impact of these various elements and the mechanisms through which they operate.

Impact of Tariff Reduction. The results for this scenario are presented in column (2) of table 3. We lower tariffs by 50 percent, but there is no liberalization of the barriers to FDI or improved market access. The estimated welfare gains to the economy are 1.3 percent of consumption or 0.6 percent of GDP.

[17] Actual tariff reductions remain are part of the accession negotiations and are not known with certainty.

The gains to the economy from tariff reduction alone come about for two reasons. Tariff reduction in Russia will lead to improved domestic resource allocation since tariff reduction will induce Russia to shift production to sectors where production is valued more highly based on world market prices. This is the fundamental effect from trade liberalization in constant returns to scale models (CRTS). In addition, tariff reduction on imports in imperfectly competitive sectors, raises the tariff ridden demand curve for imports. This increases profitability for foreigners of selling in the Russian market thereby inducing new entry by foreign suppliers until zero profits are restored. Although there is a loss of domestic varieties due to increased foreign competition, there is a net increase in varieties. The additional varieties in the imperfectly competitive sectors of Russia result in a productivity improvement for users of these goods through the Dixit-Stiglitz-Ethier effect. This result is analogous to the result found by Rutherford and Tarr (2002) in a fully dynamic model.

Impact of Improved Market Access. In column (3) of table 3, we present the results of a scenario in which we allow for improved market access (according to the terms of trade improvements of table 2), but we do not lower tariffs or barriers to FDI in services sectors. We estimate that the impact of improved market access at 0.6 percent of consumption (0.3 percent of GDP). Gains derive from improved prices for exports. But also a higher value for exports allows Russia to buy more imports and more varieties of imports increase productivity. Thus, the impact of improved market access is greater in a model with Dixit-Stiglitz variety effects than in a constant returns to scale model.

Impact of Foreign Direct Investment Liberalization in Business Services. In this scenario, labeled reform of FDI barriers in column (4) of table 3, we eliminate or reduce the discriminatory tax on multinationals in the service sectors (as shown in table 2), but there is no reduction in tariffs or improved market access. The reduction in the discriminatory tax on multinationals increases profitability for provision of services in Russia by multinationals, thereby inducing new entry by multinational service providers until zero profits are restored. Although there is a loss of domestic service varieties due to increased multinational foreign competition, there is a net increase in varieties. Russian businesses will then have improved access to the services of multinational service providers in areas like telecommunication, banking, insurance, transportation and other business services. The additional service

varieties in the business service sectors should lower the cost of doing business and result in a productivity improvement for users of these goods through the Dixit-Stiglitz-Ethier effect. We estimate that the gains to Russia from liberalization of barriers to FDI in services are about 5.2 percent of the value of Russian consumption or about 72 percent of the total gains to Russia of WTO accession.

Sector Results

Expanding Manufacturing Sectors. Sectors we estimate will expand are those that either: export a relatively large share of their output; obtain an exogenous increase in export prices as a result of WTO accession; are relatively unprotected initially compared to other sectors of the economy; or experience a significant reduction in the cost of their intermediate inputs, typically because they have a large share of intermediate inputs that come from sectors that experience productivity advances due to trade or FDI liberalization.

The manufacturing sectors that we estimate are likely to expand their output the most are non-ferrous metals, ferrous metals and chemicals. (See Jensen, Rutherford and Tarr (2004) for detailed sector results.) These three sectors are among the sectors that we assume will gain an exogenous increase in the price of its exports upon WTO accession. They are also among those that export the highest share of their output—they all export over thirty percent of the value of their output. Export intensity is important because a reduction in tariffs generally depreciates the real exchange rate . Since the real exchange rate depreciates, sectors that export intensively will gain more domestic goods for a unit of their exports.[18]

Declining Manufacturing Sectors. The sectors that contract the most are the sectors that are the most protected prior to tariff reduction and which have a relatively small share of exports. Most notably this includes machinery and equipment, food and light industry and construction materials. All of these sectors do little exporting and light industry and food are the sectors with the highest tariff rates.

[18] The real exchange depreciates because the increased demand for imports accompanying the decline in tariffs induces an increase in the price of foreign exchange. In addition, the reduction in barriers to multinational investment in the services sector depreciates the real exchange rate. This is because multinationals use more foreign skilled labor, and they must pay in foreign exchange for the foreign skilled labor from domestic sales. The depreciation of the real exchange rate encourages exports and mutes the import expansion.

Business Service Sectors. Russian business and labor interests in these sectors are not the same, and we discuss the impact on labor in these sectors first. We find that skilled and unskilled employment will expand in most, but not all, of the business service sectors. This is an application to a full-economy model of the result found by Markusen, Rutherford and Tarr (2000). They show in a more stylized model that even when foreign direct investment is a partial equilibrium substitute for domestic skilled labor, it may be a general equilibrium complement. The reason is as follows. As a result of a reduction in the barriers to foreign direct investment in these sectors, we estimate that there will be an expansion in the number of multinational firms that locate in Russia to provide business services from within Russia, and a contraction in the number of purely Russian firms. Although multinationals also demand Russian labor, though they use Russian labor slightly less intensively than Russian firms. That is, since multinationals import primary inputs, foreign direct investment is a partial equilibrium substitute for Russian labor. But as more service firms enter the market, the quality adjusted price of services falls, and industries that use services expand their demand for business services. On balance, the increase in labor demand from the increase in the demand for business services typically exceeds the decline in labor demand from the substitution of multinational supply for Russian supply in the Russian market. That is, FDI is a partial equilibrium substitute but a general equilibrium complement to Russian labor. Thus, we estimate that labor in the business services sectors will typically gain from an expansion in foreign direct investment and multinational provision of services in Russia.

Regarding capital, as a result of the removal of restrictions, we estimate there would be significant increase in foreign direct investment and an increase in multinational firms operating in Russia. We estimate that specific capital owners in imperfectively competitive sectors will lose from this increase in competition. However, we expect the increase in foreign direct investment to have diverse impacts on Russian firms. We define a firm as a multinational even if a foreign firm and a Russian firm have formed a joint venture. Multinationals will often look for Russian joint venture partners when they want to invest in Russia. Russian companies that become part of a joint venture in the expanding multinational share of the business services market will likely preserve or increase the value of their investments. Russian capital owners in business services who remain wholly independent of multinational firms, either because they

avoid joint ventures or are not desired as joint venture partners, will likely see the value of their investments decline, and the least efficient will exit the industry.[19]

This suggests that domestic lobbying interests within a service sector could be diverse regarding FDI liberalization. We estimate that labor should find it in their interest to support FDI liberalization even if capital owners in the sector oppose it. But capital owners themselves may have diverse interests depending on their prospects for acquisition by multinationals.

IV. Sensitivity Analysis

The results depend on the choice of parameters in the model as well as certain assumptions or closures. In this section, we evaluate the impact on the results of the changing the values of the key parameters or modeling assumptions in the model. We begin with key model assumptions. We then discuss the results of piecemeal sensitivity analysis on the parameters. Finally we discuss the results of our systematic sensitivity analysis.

Model Assumptons

Sensitivity Results for a 50% Cut in the Barriers to Foreign Direct Investment. In this scenario, we simulate a cut in the barriers by one-half as much as in our central scenario (shown in column 6 of table 3). But we allow for improved market access and a 50 percent cut in tariff barriers. We find that the gains to the economy are reduced to about 4.1 percent of consumption. From table 3, we can see this is slightly less than the sum of three components: (i) half of the gains from FDI liberalization; (ii) tariff reduction; and (iii) improved market access.

Rent Capture or Dissipation. Resource loss from rent seeking of licenses is a significant problem in Russia. In our central scenario we have ignored these costs. It may be appropriate, however, to assume that those that obtain the licenses use Russian capital and labor in wasteful license-seeking activities and the like. Then the ad valorem equivalence of the

[19] We assume that firms in the business services sectors must use a specific factor in order to produce output. This specific factor results in an upward sloping supply curve in each business services sector.

barriers to multinational investment are a real resource cost. As a result the estimated gains from WTO accession increase from 7.2 percent to 7.7 percent of consumption (as shown in column 7 of table 3) because the resources that were used to capture the rents become available for productive activities.

Similarly, if foreigners capture the rents initially, liberalization of the barriers will allow competition among foreigners that will result in a transfer of the rents from foreigners to Russia. Then we estimate the gains to Russia from WTO accession will increase from our central estimate of 7.2 percent to 7.5 percent of consumption.

Sector-Specific Labor. Although we have some sector-specific capital (varying by sector), in our central scenario all labor is mobile. To evaluate short-run effects, where a significant portion of labor will be unable to switch jobs between sectors, we assume that labor can not move between sectors, that is labor is "sector-specific." With sector-specific labor, wages of skilled and unskilled labor will vary across sectors in response to shifts in demand coming from WTO accession.

The aggregate results are presented in table 3, column 8. The welfare gains fall to 5.9 percent of consumption. This decline in the gains is expected when labor is sector specific since when labor is immobile, it cannot move to the sectors where it is valued most highly. What is striking about this scenario is that the gains remain substantial. This shows how important productivity effects are since without productivity effects a model with no labor market resource reallocation would produce very small gains.

While the welfare gains are smaller, no labor changes jobs in this scenario (see the rows on factor adjustments in table 3). So the "social" adjustment costs of labor are zero. Despite no dislocation of labor, the wages of workers in each sector will go up or down relative to the average wage in the economy for skilled or unskilled labor; thus, there are private adjustment costs of WTO accession, even if there are no social costs of adjustment in this short-run model.[20]

[20] See Matusz and Tarr (2000) for an elaboration of the distinction between private and social costs of adjustment.

CRTS model--No productivity effects. We also executed a CRTS version of our model where we reduced tariffs by 50 percent, allowed improved access and lowered FDI barriers. Without the Dixit-Stiglitz structure that provides the possibility of productivity gains, the welfare gains are reduced to 1.2 percent of consumption.[21]

Long-Run Comparative Steady-State Results of WTO Accession. In a long-run analysis, we should allow for the fact that WTO accession could improve the investment climate in Russia. In this scenario, we employ our comparative steady-state model. As explained in section II, the principal feature is that we allow for the fact that accession to the WTO could increase the rate of return on investment.[22] This would induce an increase in the capital stock until the marginal productivity of capital declines sufficiently that the rate of return on investment is no higher than the initial steady-state equilibrium rate of return on investment. With our comparative steady-state model, we estimate that the gains to Russia from WTO accession are 23.7 percent of consumption (11 percent of GDP). This is more than three times the estimated comparative static welfare gains. The reason the gains are larger is that we estimate that WTO accession will induce an increase in the rental rate on capital in Russia in the comparative static model by 4.9 percent. In the comparative steady-state model, this induces an expansion of the capital stock in the new equilibrium. We estimate that the capital stock will increase by about 14.4 percent of its initial level in the long-run steady-state equilibrium. With a higher capital stock, the economy is able to produce more output and there is more consumption. We typically argue that this type of model produces an upper bound estimate of the welfare gains because the foregone consumption necessary to achieve the higher capital stock is not taken into account.[23] However, Rutherford and Tarr (2002) show

[21] Without increasing returns to scale, removing barriers to FDI has no effect.
[22] Rutherford and Tarr (2003) explain why we typically, but not always find in models with product differentiation, that the rate of return on investment (the rental rate on capital divided by the cost of a unit of capital) increases. This despite the fact that we have no a priori expectation that the rental rate on capital will rise relative to the wage rate.
[23] On the other hand, Russia has had a substantial trade surplus in the past several years; the trade surplus was $46 billion in 2002, approximately the value of aggregate imports, which reflected decisions by Russian investors to invest abroad. If WTO accession can improve the investment climate in Russia, the large annual capital outflow of Russia could be turned around and invested in Russia. Then, it may be possible to achieve a larger capital stock without the foregone consumption that is typically required.

that a fully dynamic model that incorporates productivity effects like those in our present model, and that takes into account foregone consumption from investment decisions, could produce estimated welfare gains that are as large or larger than these comparative steady-state results.

Piecemeal Sensitivity Analysis

In table 4, we present the impact on welfare of varying the value of key parameters. In these scenarios, we retain the central value of all parameters except the parameter in question. In general, the gains to the economy (welfare gains) increase with an increase in elasticities, since higher elasticities imply that the economy is able to more easily shift to sectors or products that are cheaper after trade and FDI liberalization.[24] There are two parameters in the table that have a strong impact on the results: the elasticity of substitution between value-added and business services (esubs) and the elasticity of multinational firm supply (etaf). A liberalization of the barriers to FDI will result in a reduction in the cost of business services, both from the direct effect of lowering the costs of doing business for multinational service providers and from the indirect effect that additional varieties of business services allow users to purchase a quality-adjusted unit of services at less cost. When the elasticity of substitution between value added and business services is high, users have the greater potential to substitute the cheaper business services and this increases productivity. The elasticity of multinational and Russian firm supply (etaf, etad) is primarily dependent on the sector-specific factor for each firm type (foreign or domestic). When etaf is high, a reduction in the barriers to foreign direct investment results in a larger expansion in the number of multinational firms supplying the Russian market, and hence more gains from additional varieties of business services. In addition, the share of the services market captured by multinationals has a strong effect, since a liberalization results in a larger number of new varieties introduced.

Share of Expatriate Labor Employed by Multinational Service Providers. The impact of liberalization of barriers to foreign direct investment in business services on the demand for labor in the business service sectors will depend on the share of expatriate labor used by multinational firms. If multinationals use mostly Russian labor, their expansion is likely to

[24] An increase in the elasticity of substitution between varieties reduces the welfare gain. This is because when varieties are good substitutes, additional varieties are worth less to firms and consumers.

increase the demand for Russian labor in these sectors. We employed the estimates of the share of expatriate labor or specialized technology not available to Russian firms that is used by multinational service providers in Russia provided by the various Russian research institutes mentioned above. Here we estimate the impact of employing the upper or lower bound estimates of this share in all business service sectors.

We find that the impact on the welfare estimates of a lower or higher share of imported inputs in the business service sectors is only 0.1 percent of consumption. But the impact on labor demand in the business services sector is more significant. For example, skilled labor demand in telecommunications increases by 6.0 percent with our central estimates of labor demand change, but would increase by 7.5 percent with the lower shares of imported inputs by multinationals and by 4.5 percent with higher shares of labor demand by multinationals. There is a similar range of results for labor demand in most of the business services sectors. With sufficiently high share of expatriate labor use by the multinationals, the demand for labor in the business services sectors would decline, but based on the expert estimates of the use of expatriate labor, we expect to see an increase in the demand for labor in telecommunications, financial services and truck transportation, but a decline in air transportation services and science services. In all these cases, the shift in employment is less than 15 percent of initial employment.

Systematic Sensitivity Analysis

Piecemeal sensitivity analysis shows how the results change when we vary the value of key parameters one by one, with central values of all parameters except the one under consideration. In the systematic sensitivity analysis, we allow all parameters to change simultaneously. A probability distribution for each parameter is chosen. We typically choose a uniform probability distribution, with the lower and upper bounds for the values of the parameters taken from the lower and upper values of the key parameters presented in table 4. We furthermore assume that all distributions are stochastically independent.

We then run the model 30,000 times. Each time the program chooses a random configuration of parameters and executes the model with this configuration. For each variable in our model, we then harvest the sample distribution based on the 30,000 solutions. Consequently the sample distribution is not dependent on any particular set of parameter values, but represents results representative of the full distribution of parameter values.

We present the distribution of the results below for three key variables: welfare change as a percentage of consumption, output change and skilled employment changes. A full compendium or results with the sample distributions and confidence intervals is reported in Jensen Rutherford and Tarr (2004). For each reported variable, we calculate the percentage of solutions associated with a given result for the variable. The top panel in figure 2 shows that the welfare gains as a percentage of consumption are, in most cases, between 6 percent and 8 percent. The minimum value is 4.5 percent and the maximum value is 11.4 percent. The bottom panel in figure 2 shows the corresponding cumulative distribution of the welfare gains. The statistics shows that only 6.4 percent of the solutions are below a welfare gain of 6 percent and that 13.0 percent are above a gain of 8 percent. More than 80 percent of the solutions yield a gain between 6 percent and 8 percent. This shows that the welfare results are very robust within the range of 6 to 8 percent of consumption.

In figure 3, we focus on the employment effects in the six sectors where the impacts are the greatest: the three sectors with the largest increase in employment and the three sectors with the largest decline in employment. We only show the results for skilled labor, as the results for unskilled labor are very close to the results for skilled labor. We assume total employment is unchanged, so employment must expand in some sectors and contract in others. The sectors where employment expands the most are: ferrous metallurgy, non-ferrous metallurgy and chemical industry. The manufacturing sectors where employment declines the most are: mechanical engineering, light industry and food industry. The results for all six sectors show that our central results are robust to most parameter configurations, and in particular that the expanding (declining) sectors are expanding (declining) for virtually all configurations. The figure also shows that the magnitude of the results for the expanding sectors is more uncertain than the

results for the declining sectors. This is explained by the relatively greater use of business services and goods from imperfectly competitive sectors.[25]

In figure 4, we display the frequency distributions of the output changes in the same six sectors. The pattern of which sectors expand or contract is the same as for employment, but the results are more positive. Whereas economy-wide employment is fixed by assumption, output increases overall. Output expands due to greater efficiency in the use of resources, and, more importantly, due to greater productivity of factors of production from the increase in varieties of business services and differentiated goods.

Finally, in order to display systematic sensitivity results for all industries in one figure, in the upper panel of figure 5 we display bars that represent 50 percent confidence intervals for aggregate output (exports plus domestic sales) for all industries (the point on the bar is our point estimate). In the lower panel of figure 5, we show 50 percent confidence intervals for domestic output by industry. Similar figures for other variables are in Appendix B of Jesper, Rutherford and Tarr (2004).

V. Conclusions

In this paper we have developed an innovative, small, open-economy computable general equilibrium model of the Russian economy that is capable of assessing the impact of the liberalization of barriers against foreign direct investment. Surveys and estimates of the ad valorem equivalence of the barriers against foreign direct investment were prepared for this model. We find that the source of the largest gains to Russia from WTO accession is that additional multinational service providers will reduce the quality-adjusted cost of purchasing business services in Russia and that these gains are rather substantial when compared with the typical gains from constant returns to scale models of tariff liberalization. We believe that these results are consistent with the economic geography literature and the earlier urban economics literature that suggest that access to a diverse set of service providers with a domestic presence is crucial for growth. [26]

[25] Thus, variation in the values of etaf, esubs and theta_fdi have a greater impact on these sectors.
[26] See Vernon (1960), McKee (1988), Marshall (1988), Holmes (1995), Hummels (1995), Chinitz (1961) and Fujita, Krugman and Venables (1999).

References

Baldwin, Richard.E., Rikard Forslid and Jan Haaland (1999), "Investment Creation and Investment Diversion: Simulation Analysis of the Single Market Programme," in R. Baldwin and J. Francois (eds.), *Dynamic Issues in Applied Commercial Policy Analysis*, Cambridge: Cambridge University Press

Baranov, S.P. (2000), "Compiling the disaggregated version of "input-output" tables of the Russian Federation for 1995 year for consequent use as a basic data for building the general equilibrium model for the Russian Federation," mimeo.

Broda, Christian and David Weinstein (2004), "Globalization and the Gains from Variety," National Bureau of Economic Research Working paper number 10314. www.nber.org/papers/10314.

Brown, Drusilla, Alan Deardorf, Alan Fox and Robert Stern (1996), "Liberalization of Services Trade," in W. Martin and L. A. Winters, eds., *The Uruguay Round and the Developing Countries*, Cambridge: Cambridge University Press.

Brown, Drusilla and Robert Stern (2001), "Measurement and Modeling of the Economic Effects of Trade and Investment Barriers in Services," *Review of International Economics*, 9(2): 262-286.

Chinitz, B. (1961), "Contrast in agglomeration: New York and Pittsburgh," *American Economic Review, Papers and Proceedings*, 51:279-89.

Daniels, P.W. (1985), *Service Industries: A Geographical Appraisal*, New York: Methuen & Co.

Dantzig, George and Alan Manne (1974), "A Complementary Algorithm for an Optimal Capital Path with Invariant Proportions," Journal of Economic Theory, 9, 312-323.

Dee, Philippa, Kevin Hanslow and Tien Phamduc (2003), "Measuring the Costs of Barriers to Trade in Services," in Takatoshi Ito and Anne Krueger (eds.), Trade in Services in the Asia-Pacific Region, Chicago: University of Chicago Press.

Dixit, A. and J. Stiglitz (1977), "Monopolistic Competition and Optimum Product Diversity," *American Economic Review*, 76(1):297-308.

Ethier, W.J. (1982), "National and International Returns to Scale in the Modern Theory of International Trade," *American Economic Review*, 72(2):389-405.

Francois, Joseph, Bradley McDonald and Hakan Nordstom (1996), "Assessing the Uruguay Round," in Will Martin and L. Alan Winters (eds.), *The Uruguay Round and the Developing Countries*, Cambridge: Cambridge University Press.

Fujita, Masahisa, Paul Krugman and Anthony J. Venables (1999), *The Spatial Economy: Cities, Regions, and International Trade*, Cambridge: MIT Press.

Hansen, Terje and Tjalling Koopmans (1972), "On the Definition and the Computation of a Capital Stock Invariant Under Optimization," Journal of Economic Theory, 5, 487-523

Harrison, Glenn, Thomas Rutherford and David Tarr (1997), "Quantifying the Uruguay Round," *Economic Journal*.

Holmes, T. (1995), "Localization of Industry and Vertical Disintegration," Federal Reserve Bank of Minneapolis.

Hummels, D (1995), "Global Income Clustering and Trade in Intermediate Goods," Graduate School of Business, University of Chicago.

Jensen, Jesper, Thomas Rutherford and David Tarr (2004), "Economy-wide and Sector Effects of Russia's WTO Accession to the WTO," April. Availabe at: http://www.worldbank.org/russia-wto.

Kang, Joog-Soon (2000), "Price Impact of Restrictiveness on Maritime Transportation Services," in Findlay, Christopher and Tony Warren (eds), *Impediments to Trade in Services: Measurement and Policy Implications*, (London: Routledge).

Kimura, Fukunari, Mitsuyo Ando and Takamune Fujii (2004a), "Estimating the Ad Valorem Equivalent of Barriers to Foreign Direct Investment in the Telecommunications Services Sectors in Russia." Available at http://www.worldbank.org/trade/russia-wto.

Kimura, Fukunari, Mitsuyo Ando and Takamune Fujii (2004b), "Estimating the Ad Valorem Equivalent of Barriers to Foreign Direct Investment in the Maritime and Air Transportation Service Sectors in Russia." Available at http://www.worldbank.org/trade/russia-wto.

Kimura, Fukunari, Mitsuyo Ando and Takamune Fujii (2004c), "Estimating the Ad Valorem Equivalent of Barriers to Foreign Direct Investment in Financial Services Sectors in Russia." Available at http://www.worldbank.org/trade/russia-wto.

Markusen, James R. (1989), "Trade in Producer Services and in Other Specialized Intermediate Inputs," *American Economic Review*, 79:85-95.

Markusen, James R. (1990), "Derationalizing Tariffs with Specialized Intermediate Inputs and Differentiated Final Goods," *Journal of International Economics*, 28:375-384.

Markusen, James R, Thomas Rutherford and David Tarr (2000), Foreign Direct Investment in Services and the Domestic Market for Expertise," Policy and Reserach Working Paper 2413, Washington D.C.: The World Bank.

Markusen, James R, and Anthony Venables (1998), "Multinational Firms and the New Trade Theory", *Journal of International Economics*, 46:183-204.

Markusen, James R. and Anthony J. Venables (2000), "The General Theory of Endowment, Intra-Industry, and Multinational Trade", NBER working paper 5529 (1995). *Journal of International Economics*, forthcoming 2000.

Marshall, J.N. (1988), *Services and Uneven Development*, London: Oxford University Press.

Matusz, Steven J, and David G. Tarr (2001), "Adjusting to Trade Policy Reform," in A. Krueger (ed.), *Economic Policy Reform*, Chicago: University of Chicago Press.

McGuire, Greg and Michael Schuele (2000), "Restrictiveness of International Trade in Banking Services," in Findlay, Christopher and Tony Warren (eds), *Impediments to Trade in Services: Measurement and Policy Implications*, (London: Routledge).

McKee, D.L. (1988), *Growth, Development, and the Service Economy in the Third World*, New York: Praeger Publishers.

Romer, Paul. (1994), "New Goods, Old Theory and the Welfare Costs of Trade Restrictions," *Journal of Development Economics*," 43(1), February, 5-38.

Rutherford, Thomas F. and David Tarr (2003), "Regional Trading Arrangements for Chile: Do the Results Differ with a Dynamic Model?" *Integration and Trade*, Vol 7, Number 18, 117-139.

Rutherford, Thomas F. and David Tarr (2002), "Trade Liberalization and Endogenous Growth in a Small Open Economy," *Journal of International Economics*.

Rutherford, Thomas F. (1999), "Applied General Equilibrium Modeling with MPSGE as a GAMS Subsystem: An Overview of the Modeling Framework and Syntax", *Computational Economics*.

United Nations Conference on Trade and Development and World Bank (1994), *Liberalizing Trade in Services: A Handbook*, New York and Geneva: United Nations.

United Nations Conference on Trade and Development, Division on Transnational Corporations and Investment (1995 and 1996), World Investment Report 1995 and 1996, New York and Geneva: United Nations.

Vernon, R. (1960), *Metropolis 1985*, Cambridge: Harvard University Press.

Warren, Tony (2000), "The Impact on Output of Impediments to Trade and Investment in Telecommunications Services," in Findlay, Christopher and Tony Warren (eds), *Impediments to Trade in Services: Measurement and Policy Implications*, (London: Routledge).

Table 1. List of Sectors

1. Sectors where foreign direct investment from new multinational services providers is possible	
RLW	Railway transportation
TRK	Truck transportation
PIP	Pipelines transportation
MAR	Maritime transportation
AIR	Air transportation
TRO	Other transportation
TMS	Telecommunications
SCS	Science & science servicing
SSM	Public health & sports & social security
ECM	Education & culture & art
FIN	Financial services
2. Sectors where new foreign firms may provide new goods from abroad	
FME	Ferrous metallurgy
NFM	Non-ferrous metallurgy
CHM	Chemical & oil-chemical industry
MWO	Mechanical engineering & metal-working
TPP	Timber & woodworking & pulp & paper industry
CNM	Construction materials industry
CLO	Light industry
FOO	Food industry
OTH	Other industries
3. Competitive sectors subject to constant returns to scale	
ADM	Administration & public associations
AGF	Agriculture & forestry
COA	Coalmining
PSM	Communal & consumer services
CON	Construction
ELE	Electric industry
GAS	Gas
GEO	Geology & hydrometeorology
OLE	Oil extraction
OLP	Oil processing
OFU	Other fuel industries
OIN	Other goods-producing sectors
PST	Post
CAT	Public catering
TRD	Trade

Table 2. Tariff Rates, Export Tax Rates, Estimated Ad Valorem Equivalence of Barriers to FDI in Services Sectors and Estimated Improved Market Access
(ad-valorem in percent) -- by sector

	Tariff rates	Export tax rates	Estimated change in world market price	Equivalent percent barriers to FDI	
				Base Year	Post-WTO Accession
Electric industry	4.5	0.0	0.0		
Oil extraction	0.0	7.9	0.0		
Oil processing	3.8	4.6	0.0		
Gas	0.5	18.8	0.0		
Coalmining	0.0	0.0	0.0		
Other fuel industries	2.6	2.6	0.0		
Ferrous metallurgy	2.9	0.4	1.5		
Non-ferrous metallurgy	7.4	5.3	1.5		
Chemical & oil-chemical industry	7.1	1.6	1.5		
Mechanical engineering & metal-working	7.2	0.0	0.0		
Timber & woodworking & pulp & paper industry	9.9	6.9	0.0		
Construction materials industry	10.6	1.6	0.0		
Light industry	11.8	4.1	0.5		
Food industry	11.3	3.1	0.5		
Other industries	6.4	0.0	0.5		
Agriculture & forestry	8.2	0.6	0.0		
Other goods-producing sectors	0.0	0.0	0.5		
Telecommunications				33.0	0.0
Science & science servicing (market)				33.0	0.0
Financial services				36.0	0.0
Railway transportation				33.0	0.0
Truck transportation				33.0	0.0
Pipelines transportation				33.0	0.0
Maritime transportation				95.0	80.0
Air transportation				90.0	75.0
Other transportation				33.0	0.0

Source: Authors' estimates

Table 3: Impact of WTO Accession on Economy-Wide Variables in Russia: Policy Results and Decomposition of Effects
(results are percentage change from initial equilibrium)

	Benchmark	WTO accession	Tariff reform only	Improved market access only	Reform of FDI barriers only	WTO accession in steady-state model	WTO accession with partial reform of FDI barriers	WTO accession with domestic rent dissipation	WTO accession in short run model
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aggregate welfare									
Welfare (EV as percent of consumption)		7.2	1.3	0.6	5.2	23.6	4.1	7.7	5.9
Welfare (EV as percent of GDP)		3.3	0.6	0.3	2.4	11.0	1.9	3.6	2.8
Government budget									
Tariff revenue (percent of GDP)	1.4	0.9	0.8	1.4	1.4	1.0	0.8	0.9	0.8
Tariff revenue (percent change)		-33.4	-38.4	8.4	10.6	-23.3	-35.4	-33.2	-35.8
Aggregate trade									
Real exchange rate (percent change)		2.6	2.0	-0.5	1.1	4.8	1.8	2.7	3.0
Aggregate exports (percent change)		13.2	7.9	1.5	3.5	24.3	10.8	13.5	9.5
Returns to mobile factors									
Unskilled Labor (percent change)		2.5	0.4	0.1	1.9	13.2	1.0	2.7	1.9
Skilled Labor (percent change)		4.7	1.5	0.6	2.5	17.6	2.6	4.9	3.4
Capital (percent change)		4.9	2.0	0.7	3.1	19.5	3.6	4.9	4.3
Factor adjustments									
Unskilled labor (percent of non-sector specific workers who change jobs)		2.6	1.1	0.5	1.6	4.4	1.7	2.6	0.0
Skilled labor (percent of non-sector specific workers who change jobs)		2.1	0.4	0.4	1.5	2.5	1.0	2.2	0.0
Capital		0.6	0.4	0.4	0.2	0.1	0.6	0.6	0.4

Source: Authors' estimates.

Table 4: Piecemeal Sensitivity Analysis–Welfare effects

Parameter[a]	Parameter value			Hicksian equivalent variation[b] with corresponding parameter		
	Lower	Inter-mediate	Upper	Lower	Inter-mediate	Upper
esubs	0.5	1.25	2.0	5.6	7.2	9.7
esub	2.0	3.0	4.0	7.3	7.2	6.8
sigmadm	2.0	3.0	4.0	7.1	7.2	7.3
esubprimary	0.70	1.00	1.30	7.1	7.2	7.2
esubintermed	0.0	0.0	0.25	7.2	7.2	7.4
esubconsumer	0.5	1.0	1.5	6.8	7.2	7.5
etadx	3.0	5.0	7.0	7.1	7.2	7.2
etad	5.0	7.5	10.0	6.9	7.2	7.4
Etaf	10.0	15.0	20.0	5.1	7.2	8.7
theta_m(i)	see table below			7.1	7.2	7.2
theta_fdi(i)	see table below			5.2	7.2	8.4

[a] The piecemeal sensitivity analysis employs central values for all parameters (see below) other than the tested parameter and lump sum tax replacement.

[b] Hicksian equivalent variation as a percent of the value of consumption in the benchmark equilibrium.

Key:

Parameter	**Central value**	**Definitions of the parameter**
esubs	1.25	Elasticity of substitution between value-added and business services
esub	3.0	Elasticity of substitution between firm varieties in imperfectly competitive sectors
sigmadm	3.0	"Armington" elasticity of substitution between imports and domestic goods in CRTS sectors
esubprimary	0.0	Elasticity of substitution between primary factors of production in value added
esubintermed	0.0	Elasticity of substitution in intermediate production between composite Armington aggregate goods
esubconsumer	1.0	Elasticity of substitution in consumer demand
etadx	5.0	Elasticity of transformation (domestic output versus exports)
etad	7.5	Elasticity of Russian service firm supply with respect to price of output
etaf	15.0	Elasticity of multinational service firm supply with respect to price of output
theta_m(i)	varies	share of specialized imports V as a share of value added in multinational firms in sector I in the benchmark equilibrium
theta_fdi(i)	varies	share of output of service sector I captured by multinationals firms in the benchmark equilibrium

Parameter values for:	theta_fdi(i)			theta_m(i)		
	low	central	high	low	central	high
railway transportation	0.01	0.03	0.05	0.02	0.04	0.06
truck transportation	0.03	0.05	0.07	0.01	0.03	0.05
pipelines transportation	0.01	0.03	0.05	0.05	0.1	0.15
maritime transportation	0.25	0.35	0.4	0.01	0.03	0.05
air transportation	0.15	0.25	0.35	0.1	0.125	0.15
other transportation	0.02	0.04	0.06	0.03	0.05	0.07
telecommunications	0.05	0.15	0.25	0.08	0.1	0.12
science and science servicing (market)	0.05	0.1	0.15	0.1	0.15	0.2
financial services	0.05	0.1	0.15	0.01	0.03	0.05

Figure 1: Production and Allocation of Output

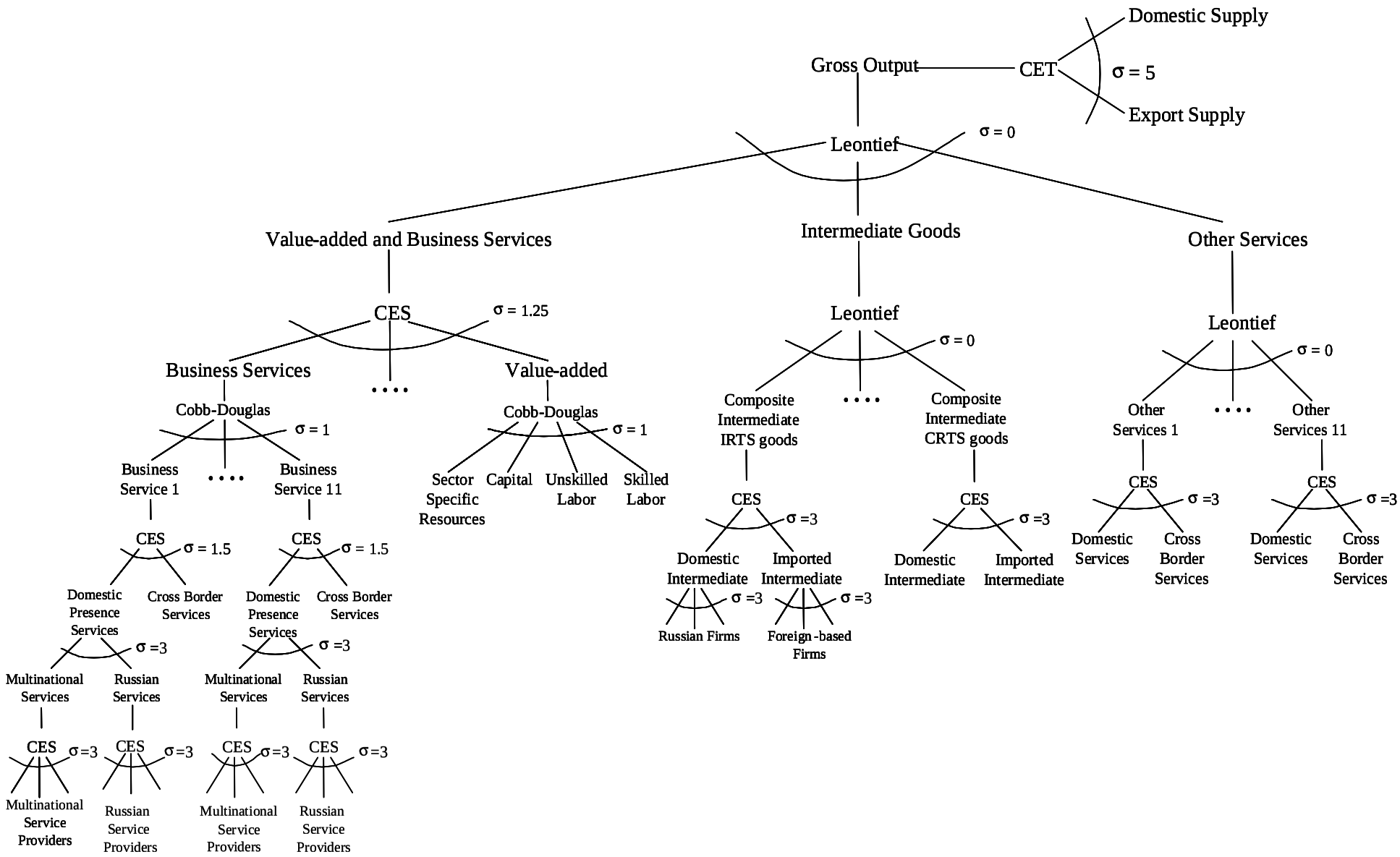
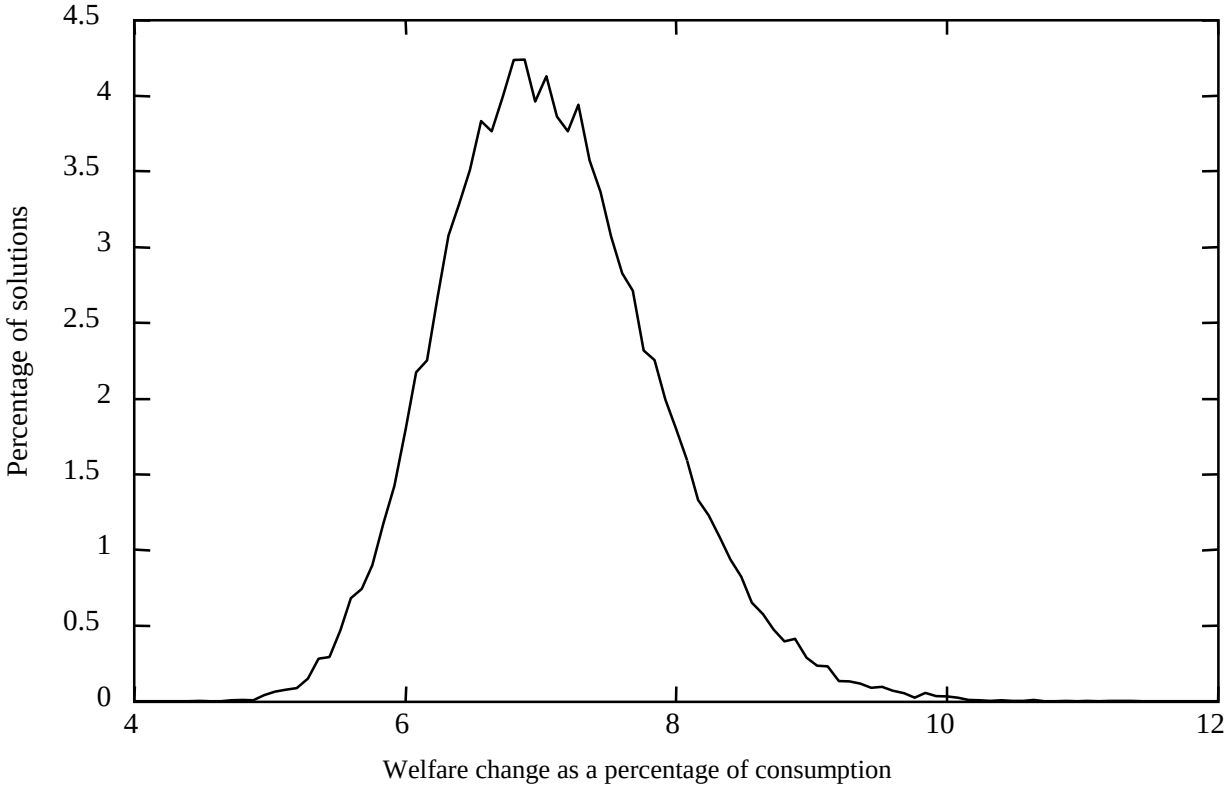


Figure 2: Frequency and cumulative distribution of welfare results



Cumulative distribution of welfare results

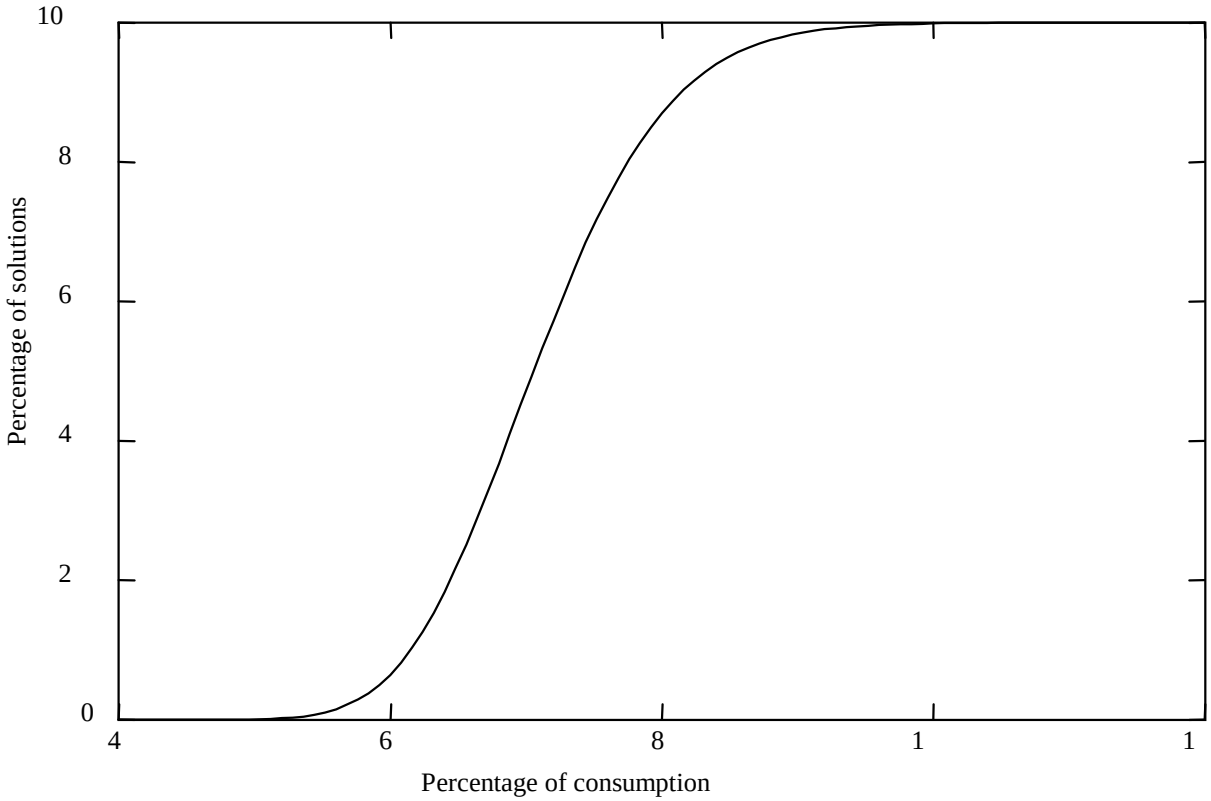


Figure 3: Frequency distributions of skilled employment impacts

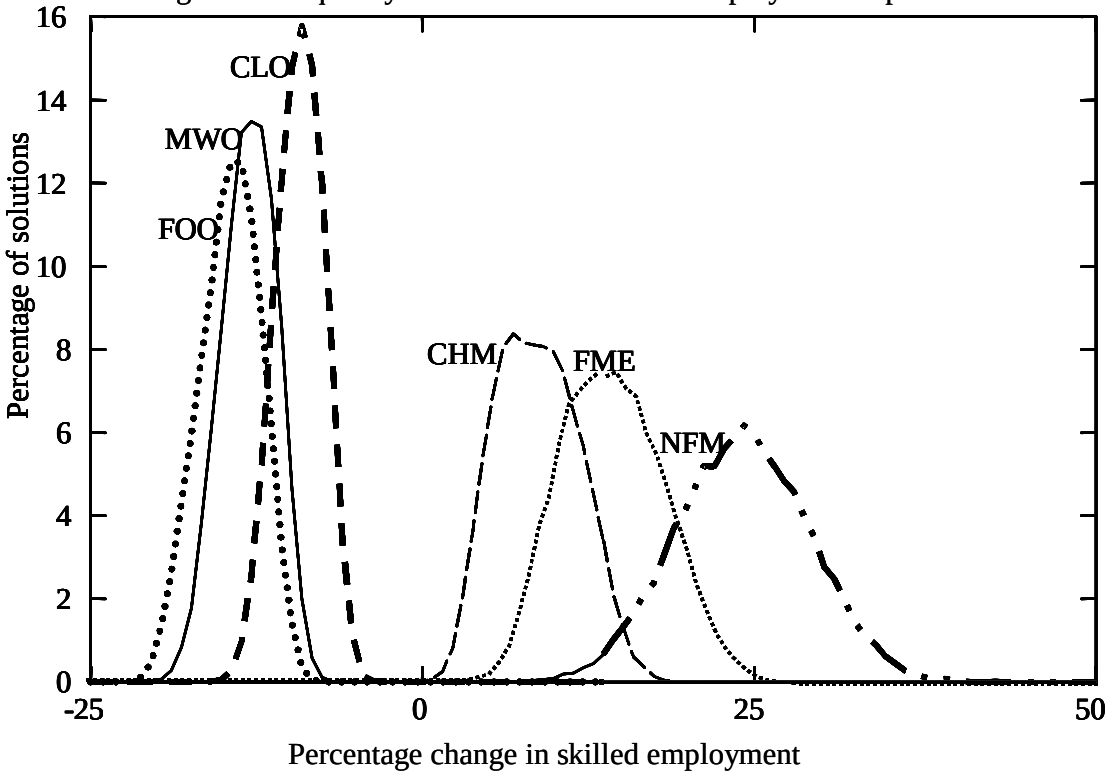


Figure 4: Frequency distributions of output impacts

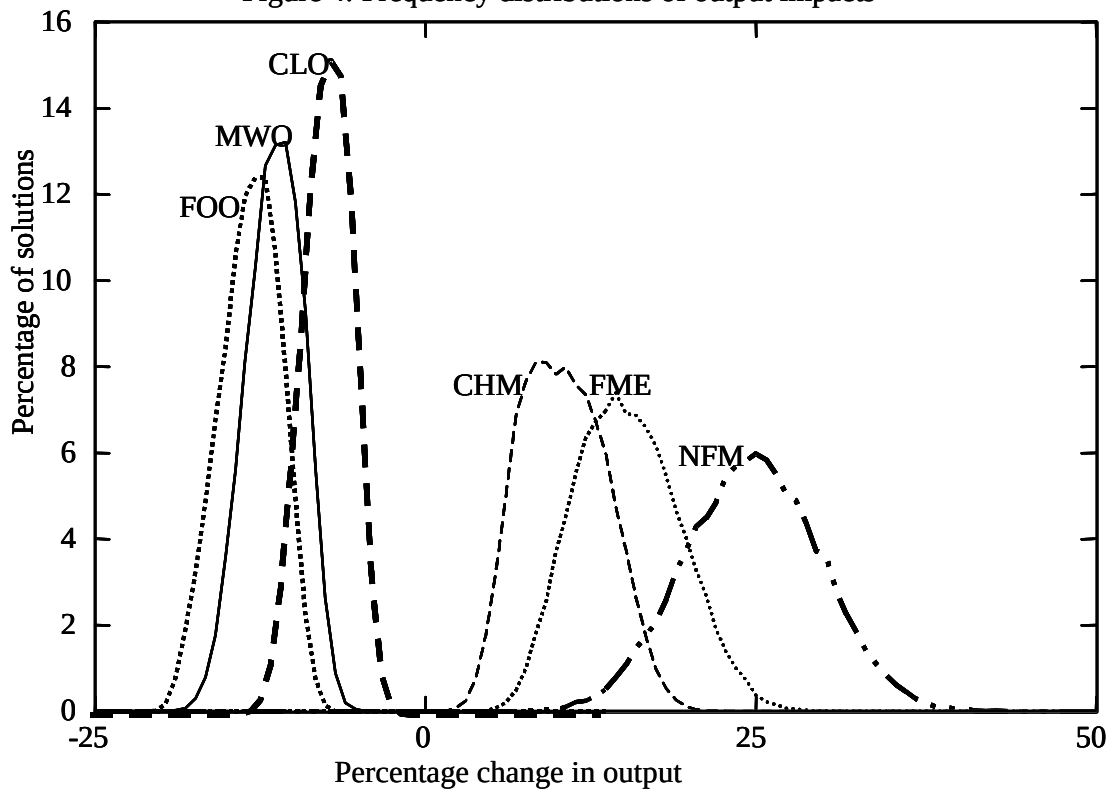
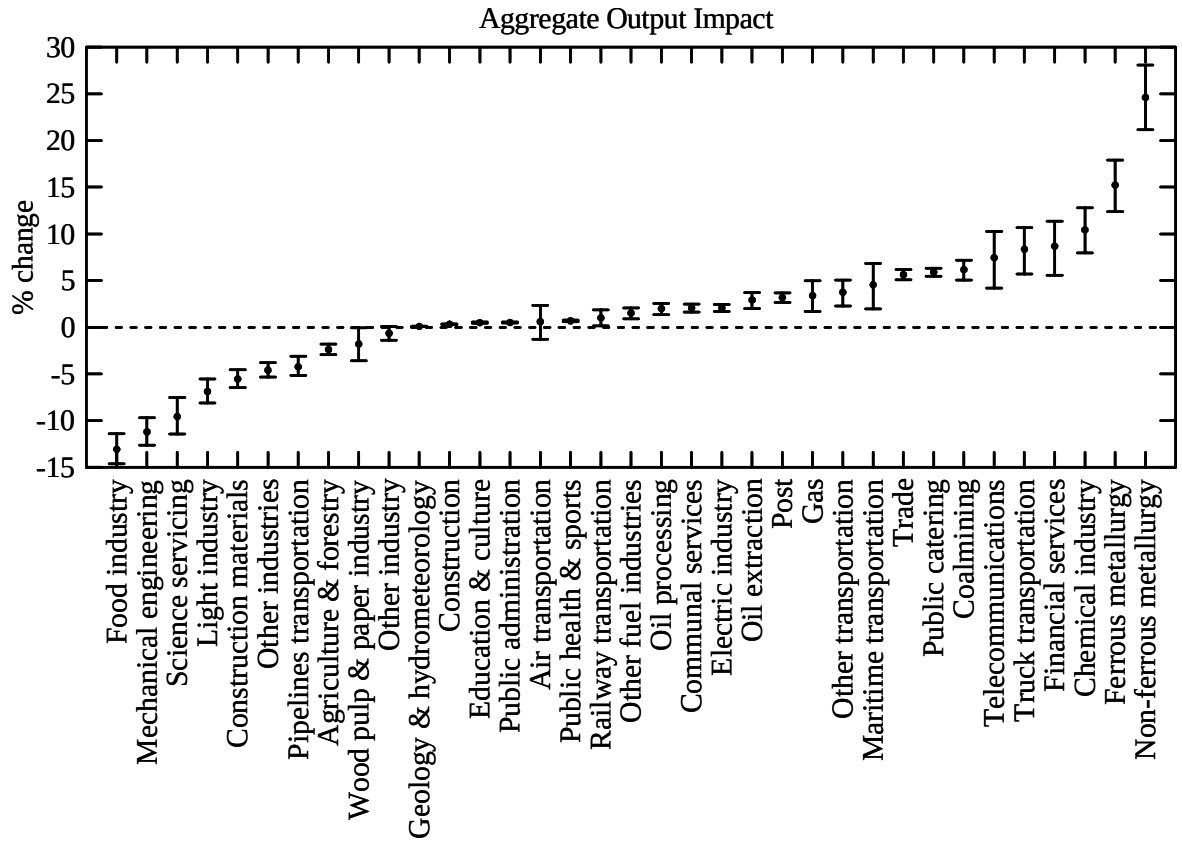
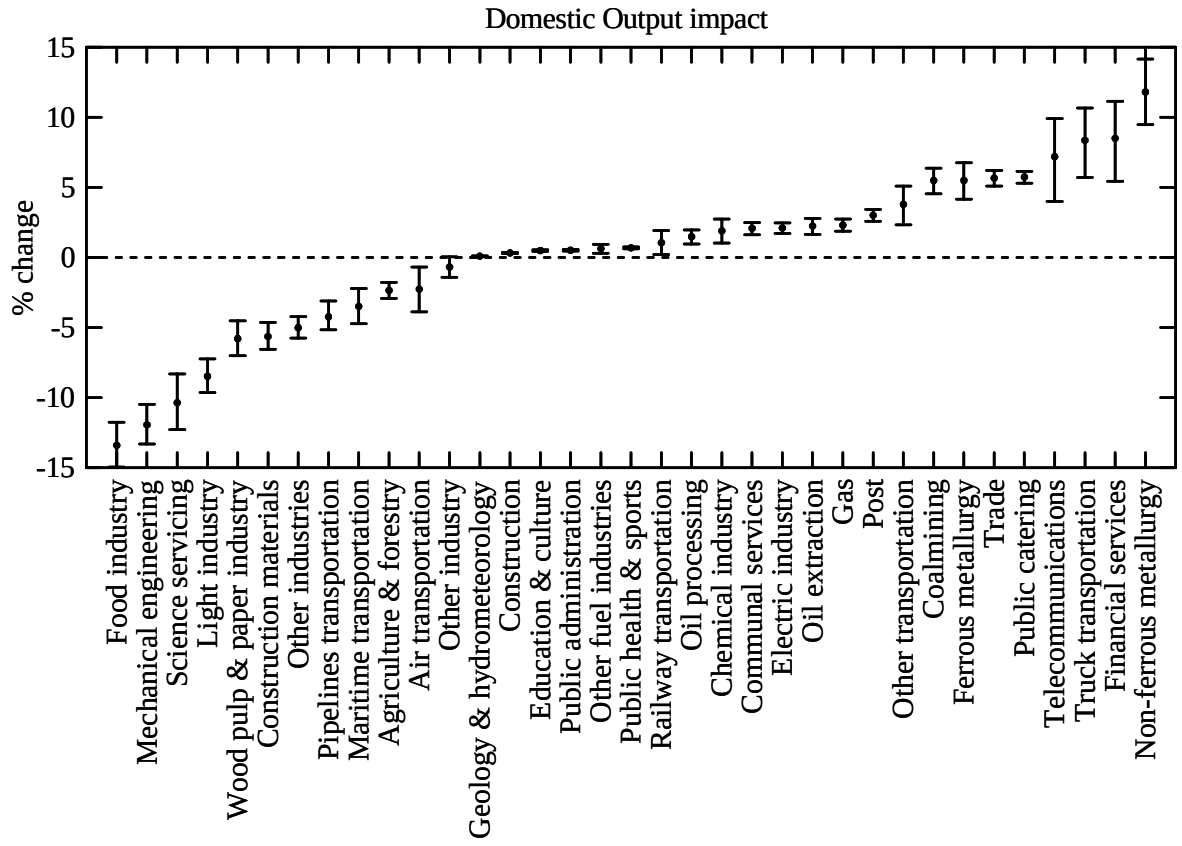


Figure 5: Aggregate output and domestic output



Note: The bars show 50% confidence intervals.



Note: The bars show 50% confidence intervals.

Appendix

The Model

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The World Bank

1 Algebraic Formulation

The model is based on the common features of general equilibrium models, including market clearance and income balance. Optimizing choices by firms imply zero pure profit with individuals firms equating marginal revenue and marginal cost. Final demand arises from a representative household who earns income from the sale of primary factors (capital, skilled and unskilled labor). The model includes one additional primary factor, imported-specialized inputs to FDI service firms.

The government levies direct and indirect taxes and purchases a vector of goods and services. In this section we outline the key features of the model in terms of the objectives and constraints facing various agents.

1.1 Consumer Behavior

Private consumption in the model arises from budget-constrained utility maximization. Preferences are represented as a Cobb-Douglas aggregate of goods and services:

$$U(C) = \sum_i \theta_i \log(c_i) \tag{1}$$

in which associated demand functions are defined in terms of goods prices p_i, consumption tax rates and aggregate income, M:

$$c_i = \frac{\theta_i M}{p_i(1+t_i^C)} \tag{2}$$

Income is defined in terms of sources of factor income: [1]

$$M = \sum_{\ell} w_\ell L_\ell + r_K \overline{K} + \sum_i r_i^S \bar{k}_i + \sum_{i,f} r_{i,f}^R \bar{R}_{if} - T_{LS} \tag{3}$$

The right side of the budget constraint includes wage income, capital earnings and net tax liabilities.

There are two types of sector-specific capital in the model. The first, corresponding to term $\sum_i r_i^S \bar{k}_i$, represents resource rents associated with energy producing sectors (gas, coal and oil). The existence of these fixed factors of production implies that the associated production sectors exhibit diminishing marginal productivity in terms of other inputs, and changes in the marginal return to these factors determines the supply response of resrouce sectors to changes in output prices.

The second type of specific capital rents are represented by the term $\sum_{i,f} r_{i,f}^R \bar{R}_{if}$. This value accounts for rents which accrue to domestic and multinational firms as a result of entry and exit to the industry. The number of firms of a particular type responds to changes in profitability. As firms enter an industry rents associated with these specific factors increas. We interpret these inputs as scarce resources specific to domestic or multinational firms.

The lump-sum tax term is determined endogenously to balance the government budget and hold public output constant (see below).

1.2 Domestic Supply

Goods and services are produced for sale in the domestic and international markets. A constant-elasticity-of-transformation (CET) function shows the transformation possibilities in a given period between domestic (D_i) and export (E_i) sales for a

[1] In the short-run version of the model we assume that labor is sector specific, in which case labor income,$\sum_\ell w_\ell L_\ell$, is replaced by $\sum_{i,\ell} w_{\ell,i}^S L_{i,\ell}^S$.

given composite output level (Y_i). The shares of sales at home and abroad are determined by relative prices given that firms produce the final good to maximize profit subject to the CET constraint:

$$Y_i = \bar{Y}_i \left[\theta_D \left(\frac{D_i}{\bar{D}_i} \right)^{\frac{1+\eta}{\eta}} + (1-\theta_D) \left(\frac{E_i}{\bar{E}_i} \right)^{\frac{1+\eta}{\eta}} \right]^{\frac{\eta}{1+\eta}} \tag{4}$$

In this equation parameters are the base year output for the domestic and export markets, respectively, and θ_D is the baseline value share of domestic sales in total sales, and η is the elasticity of transformation.

Production is associated with a nested production function of materials inputs a_{mi}, labor services $L_{\ell,i}$, and capital (K_i).[2] Given prices of intermediate goods and labor, the aggregate production sector operates so to minimize the costs of producing a given output subject to the constraint:

$$Y_i = \bar{Y}_i \min \left[a_{mi}, F_i \left(\mathcal{B}_i(a_{si}), VA_i(L_{\ell,i}, K_i,) \right) \right] \tag{5}$$

in which $a_{mi} = (a_{m_1,i}, a_{m_2,i}, \ldots)$ represents *material* inputs to sector i, while $a_{si} = (a_{s_1,i}, a_{s_2,i}, \ldots)$ stands for inputs of *business services*. Within this function service inputs substitute for primary factors trhough the production function F_i, $\mathcal{B}_i$ characterizes an aggregation of business services, and VA_i represents a Cobb-Douglas aggregate of capital, skilled and unskilled labor.

1.3 Differentiated Services

Business services produced within the domestic economy are produced by two types of imperfectly competitive firms: domestic and multinational. There is a one to one correspondence between firms and their differentiated service varieties. For clarity of notation we will dispense with the sectoral index, j in this discussion and focus on a representative aggregate of a specific business service, Z. This composite is formed as a constant-elasticity-of-substitution (CES) function of ZD (domestic) and ZM (multinational) service varieties, each of which is in turn a CES function of the

[2]For energy resource sectors, inputs of mobile capital are replaced by sector-specific capita, $\bar{k}_i$

individual varieties, zd_i and zm_i respectively.

$$Z = (ZD^{\delta} + ZM^{\delta})^{1/\delta}$$

in which

$$ZD = \left[\sum_{i=1}^{n_d} zd_i^{\delta_d}\right]^{1/\delta_d}$$

and

$$ZM = \left[\sum_{i=1}^{n_m} zm_i^{\delta_m}\right]^{1/\delta_m}$$

where n_d and n_m are the number of domestic and imported service varieties, respectively. The elasticities of substitution within product groups are: $\sigma_f = 1/(1-\delta_f)$ for $f \in \{d, m\}$. We require that δ_f is a number between 0 and 1, which implies that the elasticities of substitution within product groups exceed unity.

Domestic services ZD are produced using domestic factors of production, whereas multinational services ZM are produced using both domestic and imported inputs. Examples of these imported inputs for services produced by multinational firms include specialized technical expertise, advanced technology, management techniques and marketing expertise. These represent a wide range of specialized inputs and thereby capture a key difference between multinational and domestic production structures. Outputs of representative firms, zd_i and zm_i, are produced under increasing returns to scale with a fixed cost of entry and a constant variable cost.

Because costs involve both fixed and marginal compoenets, it is convenient to express technologies for these differentiated goods by cost rather than production functions. Let CD and CM be the (total) cost functions for producing individual domestic and multinational varieties. We impose a symmetry assumption within firm types, i.e., all multinational firms have identical cost structures, and all domestic firms that operate have cost structures identical to other domestic firms. c_d and c_m represent unit variable cost functions and f_d and f_m represent the fixed costs functions for domestic and multinational varieties respectively. Cost functions for domestic and multinational intermediates are thus:

$$C^D(zd) = c_d zd + f_d$$

and

$$C^M(zm) = c_m zm + f_m$$

in which unit and fixed costs are functions of materials costs, wages, rental costs of capital and the cost of firm-type-specific resources. Firm-type-specific capital implies increasing production costs for multinational firms entering the domestic market and falling costs for domestic firms leaving the domestic market.

Let nd and nm as variables refer to the number of domestic and multinational service firms active in equilibrium. To simplify the interpretation of results, we assume "large-group monopolistic competition." That is, individual firms regard themselves as too small to influence the composite price of their group. This implies that the ratio of the price of services to marginal cost is constant.

Let p_{zm_i} denote the price received by the producer of a representative multinational service variety, zm_i. We assume competitive demand for services, hence p_{zm_i} is a function of the value of p_Z, the market price of services:

$$p_{zm_i} = p_Z \ (ZD^\delta + ZM^\delta)^{1/\delta - 1} \ ZM^{\delta - \delta_m} \ zm_i^{\delta_m - 1}$$

Revenue of an individual zm_i producer is price times quantity.

$$p_{zm_i} \ zm_i = p_Z \ (ZD^\delta + ZM^\delta)^{1/\delta - 1} \ ZM^{\delta - \delta_m} \ zm_i^{\delta_m}$$

Large-group monopolistic competition is based on the assumption that an individual firm views Z as fixed or parametric and here, by extension, views ZM and ZD as fixed. Thus, the individual firm views all variables on the right hand side of this equation as fixed except for its own output zm_i. This implies that marginal revenue takes on a very simple form.

$$MR_{zm_i} = p_Z (ZD^\delta + ZM^\delta)^{1/\delta - 1} \ ZM^{\delta - \delta_m} \ \delta_m \ zm_i^{\delta_m - 1} = \delta_m p_{zm_i}$$

Setting marginal revenue equal to marginal cost implies that the ratio of price to marginal cost is simply $1/\delta_m$. We have assumed that all multinational varieties have an identical cost structure and the demand for all multinational varieties is identical. These "symmetry" assumptions imply that the output and price of all

multinational firms that operate will be identical. We can thus write $zm_i = zm$ and $p_{zm_i} = p_{zm}$ for all i. Similar conclusions follow for domestic firms.

Equilibrium for a symmetric group of service firms (zm or zd) is found as the solution to two equations and two unknowns. One equation is the individual firm's optimization condition, marginal revenue equals marginal cost. A second condition, arising from the free-entry condition, is that price equals average cost. This condition determines the number of firms in equilibrium.

As noted above, the crucial distinction between domestic and international firms follows from the technology through which services are produced. Domestic service providers invoke costs which are largely based on primary factors, including labor, capital (both mobile and firm-specific), and intermediate goods. Hence, we have:

$$c_d = c_d(w_\ell, r_K, r_d^R, p)$$

Firms which provide services under FDI incur many of the same costs as domestic firms, with the addition of an additional specialed input, p^V:

$$c_m = c_m(w_\ell, r_K, r_m^R, p, p^V)$$

p^V represents the cost of specialized imported inputs and depends on the international price of these items. The domestic price of V is thus defined as the product of the international price of V and the price of foreign exchange:

$$p^V = \overline{p}^V \rho$$

For our type-zm firms, equilibrium conditions characterizing both profit maximization and zero profit are given as follows (with corresponding equations for the type-zd firms):

$$MR = MC \quad \Rightarrow \quad p_{zm}\delta_m = c_m,$$

and

$$p_{zm} = AC \quad \Rightarrow \quad p_{zm} = c_m zm + f_m.$$

Solving these equations to find zm, output per firm, we get:

$$\frac{1}{\delta_m} = 1 + \frac{f_m}{c_m}\frac{1}{zm}.$$

Hence,

$$\frac{1}{\delta_m} - 1 = \frac{1-\delta_m}{\delta_m} = \frac{f_m}{c_m}\frac{1}{zm},$$

and

$$zm = \frac{\delta_m}{1-\delta_m}\frac{f_m}{c_m} = (\sigma_m - 1)\frac{f_m}{c_m}$$

The output of a given variety is larger when fixed costs are larger relative to marginal costs (scale economies are larger) and when the varieties are better substitutes. Similar results apply for domestic type firms.

In the absence of empirical evidence on the factor composition of fixed and variable costs of service production w assume that fixed and variable costs are proportional, i.e. [3]

$$c_m = \phi_m f_m$$

Dual to the output indices are cost functions. When firms minimize the cost of purchasing multinational (domestic) varieties, a cost of a unit of the composite multinational (domestic) input ZM (ZD) is:

$$CM = \left[\sum_{i=1}^{n_m} p_{zm_i}^{1-\sigma_m}\right]^{1/1-\sigma_m}$$

and

$$CD = \left[\sum_{i=1}^{n_d} p_{zd_i}^{1-\sigma_d}\right]^{1/1-\sigma_d}$$

where $\sigma_f = \frac{1}{1-\delta_f}$ for $f \in \{d, m\}$, and pzd_i is the price of the output of a domestic firm and n_d and n_m are the number of domestic and multinational firms.

Substituting the symmetry of the equilibrium into the cost functions for a unit of ZM or ZD, implies that CM and CD can be written as:

$$CM = \frac{p_{zm}}{n_m^{\sigma_m - 1}}$$

[3]Both fixed and variable costs are then the same function of factor prices. An important consequence of this assumption is that output per firm is constant. The model thus focuses solely on the efficiency impacts of FDI liberalization without introducing scale effects which might further enhance the efficiency impacts of service sector reform.

and

$$CD = \frac{p_{zd}}{n_d^{\sigma_d - 1}}$$

Since the elasticities of substitution exceed unity, the cost of obtaining an aggregate unit of multinational or domestic services decreases as the number of varieties increases. That is, additional varieties convey an externality on intermediate inputs by lowering the costs of obtaining a unit of composite services. The elasticity of the cost of a composite unit of multinational services with respect to the number of multinational varieties is $1 - \sigma_m$. Thus, an additional multinational variety conveys a larger externality for the domestic economy the better varieties substitute for each other. A similar argument applies for domestic varieties.

Alternatively, the externality can be viewed from the primal. Symmetry implies that

$$ZD = n_d^{1/\delta_d} zd$$

and

$$ZM = n_m^{1/\delta_m} zm$$

The cost of purchasing the output of domestic firms is $n_d \times zd \times p_{zd}$, which increases in proportion to the number of fimrs. But, since $\delta_d < 1$, the effective supply to the firm increases more than proportionately with the number of firms.

Note in the special case of firm-level product differentiation in which $\delta = \delta_d = \delta_m$ and $zm = zd$, Z can be written as:

$$Z = (n_d + n_m)^{1/\delta} z$$

with $z = zm = zd$. In this case domestic and imported firms, while differentiated, are perfect substitutes at the margin.

1.4 Differentiated Goods

Goods produced subject to increasing returns to scale are characterized as differentiated products of domestic and foreign firms. For simplicity, each firm is assumed

to produce a single variety. Aggregate supply in a given sector is represented by a composite of domestic and imported goods:

$$\begin{aligned} A &= \left(\sum_{j=1}^{n} x_j^{\rho}\right)^{1/\rho} \\ &= \left(\sum_{j=1}^{n_D} (x_j^D)^{\rho} + \sum_{j=1}^{n_M} (x_j^M)^{\rho}\right)^{1/\rho} \\ &= \left(n_D^{1-\rho}(\tilde{X}_j^D)^{\rho} + n_M^{1-\rho}(\tilde{X}_j^M)^{\rho}\right)^{1/\rho} \end{aligned} \tag{6}$$

In the final expression is output of a representative type k firm, and is resource inputs at marginal cost of all type k firms.

Holding total output constant, *effective supply* of either domestic or foreign varieties of commodity i increases with $(n_i^k)^{\frac{1-\rho}{\rho}}$, which is the "variety effect multiplier." The multiplier increases with n_i^k and increases as the elasticity of substitution decreases toward 1.

The supply of good i equals aggregate demand, the sum of intermediate demand, consumer demand, investment demand, government demand and the demand for good i as a trande or transport margin:

$$A_i = \sum_j a_{ij} + c_i + \bar{I}a_i^I + \bar{G}a_i^G + \mathcal{T}_i \tag{7}$$

The number of domestic and foreign varieties determine the effective supply index, A_i, and we thereby assume that the Dixit-Stiglitz productivity has an symmetric impact on both intermediate and final demand. Changes in the number of domestic and foreign varieties are reflected through changes in the price index of the commodity associated with A_i.

Trade and transport margin demands are assume to be proportional to aggregate supply, hence we have a market clearance condition of the form:

$$\mathcal{T}_i = \begin{cases} \sum_j \tau_{ij} A_j & i \in (trade, transport) \\ 0 & i \notin (trade, transport) \end{cases}$$

in which τ_{ij} represents the demand for margin commodity i in the distribution of commodity j.

1.5 Current Account

The model imposes a current account balance which requires that there be no change in the current account. The current account is calculated on the basis of commodity exports (E_i), commodity and cross-border service imports (M_i) and the specialized FDI-related imports (V_i). An increase (decrease) in imports must be compensated by a corresponding decrease (increase) in exports, holding the base year current account surplus ($\bar{D}$) fixed.

$$\sum \bar{p}_i^X E_i = \sum \bar{p}_i^M M_i + \sum \bar{p}_i^V V_i + \bar{D}$$

1.6 Tax Revenue and the Public Budget

In the model, the government collects a variety of indirect taxes. These taxes and the associated ad-valorem rates include the taxes on output (t_i^y) , taxes on intermediate inputs (t_{ij}^a) , tariffs (t_i^M), taxes on public demand (t_i^G), taxes on investment demand (t_i^I) , taxes on exports (t_{ir}^X), and taxes on consumption (t_i^C). The government budget constraint is then:

$$p^G G = T_Y + T_a + T_M + T_G + T_I + T_X + T_C + T_{LS}$$

in which T_k represents revenue from tax instrument k, and T_{LS} represents direct (lump-sum) taxes. The model features a constant level of public provision, which is achieved through adjustment of the level of lump sum tax.

2 Variables

2.1 Sectors in the Model

Y(I) y_i Sectoral production. This is an index of the scale of operation describes both inputs and outputs. Outputs are CET joint products for the domestic and export market, with magnitudes which are determined by relative prices.

A(I) a_i Armington supply. This activity delivers goods to the domestic market which are a composition of domestic, imported and FDI inputs. It also applies trade and transportation margins.

E(I) e_i Export supply. This is an accounting activity which keeps track of the scale of commodity exports.

M(I) m_i Import activity. This is an accounting activity which keeps trace of commodity imports. m_i represents both cross-border and FDI-related imports in sector i.

S(F,I) s_{fi} Dixit-Stiglitz supply index. This activity level is an index of FDI inputs. The output coefficient for this activity incorporates variety-adjustments reflecting the number of firms in operation.

N(F,I) n_{fi} Number of firms. This activity accounts for fixed costs associated with the creation of new varieties of either domestic or multinational firms in the domestic market.

Z(F,I) z_{fi} Total cost by firm type. Our model is based on an assumption of a common factor composition of fixed and variable costs. This activity creates a composite firm-level cost index which enters into both variable and fixed costs of production (sectors s_{fi} and n_{fi}, respectively).

2.2 Prices

PFX ρ Price of foreign exchange. Trade balance implies no change in net indebtedness – the difference between the CIF value of imports and the FOB value of exprots remains unchanged as part of the any simulation.

P(I) p_i Armington price, a composite price index incorporating trade and transport margins.

PD(I) p_i^D Domestic market price, evaluated at producer prices.

PX(I) p_i^X Export price, evaluated at producer prices net of trade and transportation margins.

PM(I) p_i^M Import price, gross of tariff but net of trade and transport margins within the domestic economy.

PL(L) w_ℓ Wage rates for skilled and unskilled labor.

RK r_K Return to capital, a rental price which describes changes in the relative price of intersectorally mobile capital.

RSS(I) r_i^S Return to sector-specific capital which enters into the primary energy sectors (GAS,COA,OLE)

PR(F,I) r_{fi}^R Price of firm-type specific factor, representing infra-marginal rents for domestic and multinational firms. The presence of this specific factor implies an upward-sloping supply schedule for both domestic and multinational firms.

PDS(F,I) p_{fi}^{DS} Variety-adjusted price of Dixit-Stiglitz aggregate, a price index which accounts for the efficiency impact of changes in the number of firms operating in the domestic economy.

PMC(F,I) p_{fi}^{MC} Firm-specific index of fixed and variable cost, the commodity produced in sector z_{fi}.

2.3 Income Levels

RA M Representative household income

TLS T_{LS} Lump-sum tax associated with public budget constraint

3 Equations

3.1 Arbitrage Conditions

$\perp y_i$ The value of domestic and export market supply from sector i equals the cost of inputs. Inputs are combined in a nested CES producting function which may include any of the following: materials (p_m), business services (p_s), skilled and unskilled labor (w_ℓ), mobile capital (r^K), and sector-specific capital (r_i^S):

$$CET^y(p_i^D, p_i^X) = COST^y(p_m, p_s, w_\ell, r^K, r_i^S)$$

$\perp a_i$ The consumer price of a commodity reflects the cost of domestic, imported and FDI inputs as well as associated trade and transportation margins:

$$p_i = \begin{cases} CES^A(p_i^M, p_{Di}^{DS}, p_{Mi}^{DS}) + \sum_k \tau_{ki} p_k & i \in \mathcal{IRTS} \\ CES^A(p_i^D, p_i^M) + \sum_k \tau_{ki} p_k & i \in \mathcal{CRTS} \end{cases}$$

$\perp e_i$ The relative price of exports is equal to the (foreign-currency denominated) FOB world market price ($\bar{p}_i^X$) times the price index of foreign exchange:

$$p_i^X = \bar{p}_i^X \rho$$

$\perp m_i$ The relative price of imports is equal to the (foreign-currency denominated) CIF world market price ($\bar{p}_i^M$) times the price index of foreign exchange:

$$p_i^M = \bar{p}_i^M \rho$$

$\perp s_{fi}$ Consistent with large-group monopositic competition, the purchase price of firm output is equal to the marginal cost times the inverse elasticity of demand:

$$p_{fi}^{DS} = c_{fi}/\sigma_f \quad \forall i \in \mathcal{IRTS}$$

in which the costs functions of domestic and multinational firms are determined through the prices of domestic and imported inputs:

$$c_{d,i} = c_d(w_\ell, r_K, r_{d,i}^R, p)$$

and

$$c_{m,i} = c_m(w_\ell, r_K, r_{m,i}^R, p, \overline{p}_i^V \rho)$$

$\perp n_{fi}$ Free entry assures zero profits in any sector. This implies that gross revenue is equal to the sum of fixed and variable costs of production. (ϕ_{fi} is a scale factor reflecting the magnitude of fixed costs per firm which calibrated based on zero profits in the benchmark data):

$$c_{fi}(\phi_{fi} n_{fi} + S_{fi}) = p_{fi}^{DS} S_{fi} \quad \forall i \in \mathcal{IRTS}$$

$\perp z_{fi}$ A single activity produces composite inputs for both fixed and variable costs of production or firm time f in sector i. Production costs include domestic inputs (p_i^D), imported inputs (p_i^V) and firm-type-specific capital (p_{fi}^R):

$$c_{fi} = \left[\alpha_{fi}^D p_i^D + \alpha_{fi}^V p_i^V\right]^{1-\beta_{fi}} (r_{fi}^R)^{\beta_{fi}} \quad \forall i \in \mathcal{IRTS}$$

Imported inputs are in turn determined by the international price of FDI-related services:

$$p_i^V = \bar{p}_i^V \rho$$

3.2 Market Clearance Conditions

$\perp \rho$ Trade balance constraint – the FOB value of exports equals the CIF value of imports plus the current account deficit:

$$\sum \bar{p}_i^X E_i = \sum \bar{p}_i^M M_i + \sum \bar{p}_i^V V_i + \bar{D}$$

FDI-related imports in this equation are determined both by output and by the number of firms:

$$V_i = \sum_f (S_{fi} + \phi_{fi} n_{fi}) \frac{\partial c_{fi}}{\partial p_i^V}$$

$\perp p_i$ Commodity markets – aggregate supply equals intermediate demand, final demand, investment demand and public demand:

$$A_i = \left(\sum_j y_j \frac{\partial COST_j^y}{\partial p_i} + A_j \tau_{ij} \right) + \theta_i M / p_i + \bar{I}a_i^I + \bar{G}a_i^G$$

$\perp p_i^D$ Domestic output markets – supply of domestic goods equals sales to aggregate plus sales to domestic and multinational firms:

$$D_i = \begin{cases} A_i \frac{\partial CES_i^A}{p_i^D} & i \in CRTS \\ \sum_f (S_{fi} + \phi_{fi} n_{fi}) \frac{\partial c_{fi}}{\partial p_i^D} & i \in IRTS \end{cases}$$

$\perp p_i^M$ Import markets – aggregate imports include sales to the aggregate demand plus sales to domestic and multinational firms:

$$M_i = A_i \frac{\partial CES_i^A}{p_i^M}$$

$\perp w_\ell$) Labor supply equals labor demand:

$$\bar{L}_\ell = \sum_i y_i \frac{\partial COST_i^y}{\partial w_\ell}$$

$\perp r_K$ Capital supply equals capital demand:

$$\bar{K} = \sum_i y_i \frac{\partial COST_i^y}{\partial r_K}$$

$\perp r_i^S$ Sector-specific capital supply equals capital demand:

$$\bar{k}_i = y_i \frac{\partial COST_i^y}{\partial r_i^S}$$

$\perp p_{fi}^{DS}$ Firm-specific capital supply equals capital demand:

$$\bar{R}_{fi} = \beta_{fi} c_{fi} z_{fi} / r_{fi}^R$$

$\perp p_{fi}^{DS}$ Firm output equals demand:

$$S_{fi} = A_i \frac{\partial CES_i^A}{\partial p_{fi}^{DS}}$$

$\perp p_{fi}^{MC}$ Supply of firm-specific costs equals the sum of variable and fixed costs:

$$z_{fi} = s_{fi} + \phi_{fi} n_{fi}$$

3.3 Income Balance Conditions Conditions

$\perp M$ Household income equals the sum of returns to labor and capital less lumpsum taxes:

$$M = \sum_{\ell} w_{\ell} L_{\ell} + r_K \overline{K} + \sum_{i} r_i^S \bar{k}_i + \sum_{i,f} r_{i,f}^R \bar{R}_{if} - T_{LS}$$

$\perp T_{LS}$ Government income constraint determines lump-sum taxes at a rate which produces no change in the level of public sector output:

$$T_{LS} = T_Y + T_a + T_M + T_G + T_I + T_X + T_C - \sum_{i} p_i (\bar{I} a_i^I + \bar{G} a_i^G) - \rho \mathcal{F}$$

4 Appendix: Calibration

We have a model in which there are N sectors, a subset of which involve production subject to increasing returns to scale and large-group monopolistic competition. In such a setting, the individual firm perceives itself ass atomistic, yet it faces a downward sloping demand curve for its differentiated good. The elasticity of demand for an individual firm's product is essentially independent of the number of firms in the market, and the markup of price over marginal cost is therefore constant.

The key elaboration over the standard monopolistic competition model which we have made in this analysis is to differentiate domestic and FDI firm types, both in the benchmark equilibrium and in the counterfactual calculation. There are many domestic and many multinational firms, but they are subject to different regulatory constraints and implicit taxes in the base equilibrium data. Furthermore, the two types of firms produce output using different technologies, e.g. FDI firms have a higher imported value share in production.

In this appendix we first go through the detailed logic of the imperfect competition model and outline first-order conditions and market clearance equations which define an equilibrium. Then we describe how we find a base year equilibrium dataset based on aggregate sectoral flows from the input-output table and a few additional statistics which characterize the base year activities of domestic and FDI firms.

Following the standard scale economy formulation with declining average cost

and constant marginal cost, there are fixed and variable components of total cost. Hence, for a given firm type f in a typical industry,[4] the total cost function is given by:

$$C_f(q) = F_f + c_f q$$

in which F_f represents fixed costs and c_f is the constant marginal cost of a representative type f firm.

The equilibrium condition for profit maximization can be found by solving

$$\max \Pi_f(q) = p_f(q)q - C_f(q)$$

or

$$p_f \left[1 - \frac{1}{\epsilon_f}\right] = c_f$$

When the elasticity of demand, ϵ_f is constant, then the markup on marginal cost is fixed. In the model we write this pricing equation as

$$p_f = (1 + \mu_f)c_f$$

in which $\mu_f = 1/(\epsilon_f - 1)$ is the optimal markup expressed on a net basis.

There are two firm types: domestic ($f = D$) and foreign ($f = F$). Individual firms are symmetric within the two categories, so that under an assumption of free entry the zero profit condition determines the number firms in each type by equating

[4]The implicit industry subscript i is suppressed. We subsequently denote imperfectly competitive sectors as a subset of all commodities, $\mathcal{I} \in I$.

markup revenue to fixed costs:

$$\mu_f c_f N_f q_f = \mu_f c_f Q_f = N_f F_f$$

in which $Q_f = N_f q_f$ is aggregate output of type f firms.

An important idea in the model formulation is that free entry implies zero excess profits, so that the value of markup revenue equals the value of aggregate fixed costs. Hence, we have an identity that relates total expenditure for a type of good to total cost of production for that good:

$$p_f Q_f = c_f Q_f + N_f F_f = N_f C_f(q_f)$$

Any rents generated by markups over marginal cost accrue to fixed costs of production. The production costs, in turn, are composed of three components. where

d_f^D represents domestically produced inputs to firm production,

d_f^M represents imported inputs to firm production,

d_f^N represents inputs of firm-type-specific factors

In the absence of specific data we assume that the composition of inputs to fixed and variables costs are identical and represent an identical aggregation of domestic,

imported and firm-type-specific inputs:[5]

$$c_f Q_f + N_f F_f = G_f(d_f^D, d_f^M, d_f^N)$$

The primary data source for our model is an input-output table for 1995 in which a number oindividual service sectors have been disagggregated. The source data relevant to the imperfectly competitive sectors include:

$\overline{D}_i$ Supply to the domestic market,

$\overline{E}_i$ Exports,

$\overline{M}_i$ Aggregate imports

$\overline{VA}_i$ Sectoral value-added

$\overline{ID}_i$ Sectoral intermediate demand

$\overline{A}_i$ Aggregate domestic expenditure

$\overline{TT}_i$ Trade and transport costs

These data satisfy the conventional input-output accounting identities. First, the value of aggregate expenditure equals the sum of sales by domestic producers and imports:

$$\overline{A}_i = \overline{D}_i + \overline{M}_i$$

[5]When marginal and fixed costs have an identical composition and the markup over marginal cost is constant, then the ratio of fixed costs to variable costs remains constant, resulting in constant output per firm.

Second, the value of output exhausts the cost of production:

$$\overline{D}_i + \overline{E}_i = \overline{VA}_i + \overline{ID}_i$$

In addition to the input-output statistics we add three additional data which characterize imperfectly-competitive sectors and FDI activities:

θ_i^{FDI} Fraction of base year output in sector i which is supply by FDI firms.

$\theta_{f,i}^{M}$ Share of production inputs for type f firms which are imported.

η_{fi} Elasticity of supply of type f firms in sector i with respect to the rate of return.

τ_{fi} Implicit tax on firm type f in sector i, representing base year barriers to FDI.

The calibration procedure infers a set of benchmark equilibrium values so as to retain benchmark consistency and applies additional assumptions regarding the cost structure of firms and their market share. The values which are inferred by the calibration process include:

D_i Domestic supply to the domestic market,

M_i Aggregate imports

VA_i Sectoral value-added,

A_i^D "Ancillary demand" for domestic goods or services, representing domestic output from sector i which is unrelated to the output of imperfectly competitive firms.

A_i^M "Ancillary demand" for imported goods, representing imports of goods associated with sector i which is unrelated to the output of imperfectly competitive firms.

$MC_{f,i}$ Aggregate marginal cost ($N_f c_f(q_f)$),

$FC_{f,i}$ Aggregate fixed costs ($N_f F_f$))

Firms engaged in foreign direct investment produce a specified fraction of output:

$$d_{f,i}^S = \theta_i^{FDI} \sum_{f'} d_{f',i}^S \quad i \in \text{FDI} \tag{8}$$

The import share of cost for FDI firms is defined by $\theta_{f,i}^M$:

$$d_{f,i}^M = \theta_{f,i}^M (d_{f,i}^M + d_{f,i}^D) \quad i \in \text{FDI} \tag{9}$$

Elasticity of supply for firm costs:

$$\eta_{fi} d_{f,i}^N = d_{f,i}^D + d_{f,i}^M \quad i \in \mathcal{I} \tag{10}$$

Aggregate imports include imported inputs to the FDI and Dixit-Stiglitz goods sectors and ancillary import demand:

$$M_i = \sum_f d_{if}^M + A_i^M \quad i \in \mathcal{I} \tag{11}$$

Supply to domestic market equals sales to firms plus ancillary demand:

$$D_i = \sum_f d_{f,i}^D + A_i^D \quad i \in \mathcal{I} \tag{12}$$

Aggregate market supply is unchanged:

$$\overline{A}_i = A_i^D + A_i^M + MC_{f,i}(1+\mu_{f,i}) + \overline{TT}_i \quad i \in \mathcal{I} \tag{13}$$

Balance between firm supply and demand:

$$d_{f,i}^D + d_{f,i}^M + d_{f,i}^N = (MC_{f,i} + FC_{f,i}+)\,(1-\tau_{fi}) \quad i \in \mathcal{I}$$

Value-added in the increasing returns sectors must be adjusted proportionally with changes in the value of output in order to retain zero profit, hence:

$$VA_i - \overline{VA}_i = (D_i - \overline{D}_i)(1-t_i^y) \quad i \in \mathcal{I} \tag{14}$$

Free entry drives profits to zero, so fixed cost equals the value of markup revenue:

$$FC_{f,i} = \mu_{f,i} MC_{f,i} \quad i \in \mathcal{I} \tag{15}$$

Adjustment targets are made for made for both imports and value-added, and the relative importance of adjustments depend on a calibration parameter Γ which is assigned a value of 0.5:

$$\min Z = \sum_{i \in \mathcal{I}} \Gamma \frac{(VA_i - \overline{VA}_i)^2}{\overline{VA}_i} + (1-\Gamma)\frac{(M_i - \overline{M}_i)^2}{\overline{M}_i}$$